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PROGRESS REPORT ON RESEARCH AND RELATED SERVICE.
APPLICABLE TO
SHEEP AND WOOL

Including Work in United States Department of Agriculture
and Certain State Work Financed in Part with
Agricultural Marketing Act Funds

Prepared for Use in Connection with the
October 1956 Meeting of the
Sheep and Wool Research and Marketing
Advisory Committee

.....
This progress report is a "tool" for: (1) administrative use in program development, coordination and evaluation; (2) advisory committee use in formulation of recommendations in regard to present and future programs. The material in the report is not for publication. Included are many tentative or indicated findings that have not been sufficiently tested for public release. As soon as these results are ready for release, the information will be released promptly through established channels. The report also includes research findings that have already been released. The publications containing the public release are cited. Public reference to the findings that have been released should mention the publication in which the release was made, NOT this progress report.

For the reasons given, copies of this report are available only to research administrators and workers directly concerned with the development and conduct of the program and to advisory committee members. Those receiving it are asked to observe strictly the limitation: "Administratively Confidential -- Not to be Quoted or Copied."
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UNITED STATES DEPARTMENT OF AGRICULTURE
Washington, D. C.
October 1956

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CURRENT SERIAL RECORDS

FUNCTIONS OF ADVISORY COMMITTEES

The Sheep and Wool Research and Marketing Advisory Committee is one of a number of committees authorized by Congress in 1946 to advise the Department of Agriculture with respect to specific research and service programs.

The committees have been asked to consider all of the research and marketing service work of the Department in their respective fields. This is in recognition of the value the Department places upon the advice and counsel received and is in accord with suggestions of Congressional committee members who are directly concerned with the work.

These committees are performing an important function in advising with respect to the development of the Department's research and marketing service programs. However, it is recognized that the implementing and administering of these programs are the responsibility of the Department.

The functions of the advisory committeemen include:

1. Acquainting themselves with the problems of producers, all segments of the industry and of other groups, and presenting them for committee consideration.
2. Reviewing and evaluating the current research and marketing service programs of the Department, including work under way at Federal laboratories and field stations.
3. Recommending adjustments in the Department's program, including priorities for new work and expansion of work under way.
4. Developing a better understanding of the nature and value of the agricultural research program, explaining it to interested persons, groups and organizations and encouraging the wider and more rapid application of the findings of research.

COOPERATION

Much of the research on wool covered in this report is conducted in cooperation between agencies of the United States Department of Agriculture and the State experiment stations. The studies find their origin in problems of producers, processors, distributors and consumers, and representatives of these groups frequently participate in the cooperation. Cooperative programs are jointly planned and conducted in a manner to make full use of the personnel and resources of each participating group with the minimum of duplicative effort. The results of cooperative research are jointly prepared in the form of uniform recommendations.

SYMBOLS USED TO DESIGNATE REPORTING AGENCIES

ARS - Agricultural Research Service

- ADP - Animal Disease and Parasite Research Branch
- APH - Animal and Poultry Husbandry Research Branch
- CH - Clothing and Household Research Branch
- ENT - Entomology Research Branch
- EU - Eastern Utilization Research Branch
- SWC - Soil and Water Conservation Research Branch
- WU - Western Utilization Research Branch

AMS - Agricultural Marketing Service

- AEC - Agricultural Economics Division
- AEs - Agricultural Estimates Division
- BS - Biological Sciences Branch
- LD - Livestock Division
- LO - Liaison Office, State Departments of Agriculture
- MD - Market Development Branch
- MOC - Market Organization and Costs Branch

FAS - Foreign Agricultural Service

FCS - Farmer Cooperative Service

FES - Federal Extension Service

FS - Forest Service

RMR - Division of Range Management Research

PROGRESS REPORT
for
SHEEP AND WOOL RESEARCH
AND MARKETING ADVISORY COMMITTEE

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PROGRESS REPORT
For
SHEEP AND WOOL RESEARCH AND MARKETING
ADVISORY COMMITTEE MEETING
October 8-10, 1956

I. PRODUCTION

A. WOOL

1. Detection of Carriers of Recessive Black in Wool Fibers

ARS-APH

The appearance of black lambs in a flock of Rambouillet sheep has emphasized the need for a reliable test for the detection of heterozygous sheep. The "dopa" reaction, a histochemical procedure by means of which the pigment producing capacity of the skin may be observed, was tried in an effort to identify the individuals carrying the recessive black gene. The test was made on fresh skin samples taken from both Rambouillet and Columbia sheep at the U. S. Sheep Experiment Station, Dubois, Idaho. Findings at this time indicate that only positive results can be considered since a negative result does not necessarily indicate an absence of the pigment potential. The dependability of the "dopa" reaction for the Rambouillet and Columbia sheep must await the outcome of future breeding tests.

2. Causes of Important Differences in Wool Fiber Diameters Investigated

ARS-APH

During the past several years rather severe drought conditions have prevailed over most of the New Mexico ranges. During this time wide yearly fluctuations have been observed in the fiber diameter measurements in the fleeces of the yearling ewes. These differences have been more apparent in the fiber diameter as measured in microns than in the visual grade. Yearly differences have been greater in the coarse wool breeding groups than in the fine wool groups. The range between years in the coarse wool sheep has varied from quarter blood in the best years to half blood grade in the poorest years, a range of over 9 microns. Since considerable selection pressure is applied toward coarser fleeces in some of the lines of sheep it became apparent that yearly differences and other factors which may have an effect on fiber diameter should be investigated.

The effects of breeding groups, years, age of dam, and type of birth and rearing on fiber diameter were studied on 750 yearling ewes, during the five year period 1950 through 1954. Years and breeding groups accounted for most of the total variation in fiber diameter. Ewes born of 2-year old mothers had significantly coarser fleeces than ewes born from 3-year old and older mothers. This difference is, no doubt, a genetic change indicating that the fleeces of the sheep in the flock are gradually getting coarser. The difference in fiber diameter due to type of birth and rearing was not significant.

The fiber diameter followed the same trend as body weight and fleece weight. In years when these weights were greatest, the fiber diameter was the coarsest. The fine wool groups did not vary as much between years as the coarse wool groups. This breed by years difference was highly significant indicating a genetic-environmental interaction.

3. The Amount of Clean Wool Produced by Individual Sheep

ARS-APH

Clean wool content per fleece is important in a breeding program designed for wool improvement as clean wool is the most accurate measure of an animal's wool producing ability. The amount of clean wool produced by each sheep is no doubt a function of the density of the fleece, the size of the surface area on which it grows, and the length and fineness of the fibers. To study the accuracy of predicting clean fleece weight, three different methods were used in comparison to actual clean fleece weight obtained by scouring the whole fleece. These methods were: (1) A method described by Neale and McFadden at the New Mexico Agr. Expt. Sta., (2) scouring a small side sample and correcting the sample for residuals, and (3) the small sample uncorrected for residuals. In addition to these three methods, multiple regression equations were used to predict clean fleece weight from wool density, body weight, staple length and grease fleece weight.

The method described by Neale and McFadden appears to be as accurate and much less expensive than scouring small samples. The correction of small samples for residuals appears to be unnecessary if a reasonably careful job is done when scouring the samples. Multiple regression equations involving all four independent variables were more accurate than any of the other methods studied in estimating clean fleece weight, and gave a multiple correlation coefficient (R) of 0.91. However, as shown by the multiple correlation coefficient, very little information is lost if density or body weight or both are omitted. When staple length is omitted, the R value drops from 0.91 to 0.82 and when grease fleece weight is omitted, the R value drops to 0.73. When both density and body weight are omitted, the R value only drops to 0.89.

Publications

Estimation of clean fleece weight from small side samples and from wool density, body weight, staple length, and grease fleece weight, George M. Sidwell, Gordon L. Jessup, Jr., and W. D. McFadden. Jour. of Animal Science 15(1): 218-224, February 1956.

4. Comparison of Sorting Methods

ARS-APH

Fourteen lots of wool from the 1955 clip at Dubois, Idaho, were processed into top by a commercial mill. These consisted of sorted, partially sorted, and unsorted lots of five different grade sorts of wool except the partially sorted lots for fine staple combing and fine French combing were combined. Duplicate five-pound samples

of grease wool were drawn from each lot at the mill and processed into top on the French comb at Beltsville.

Fineness determinations on the mill lots showed very little difference among the three degrees of sorting in average fiber diameters in microns. In every grade grouping, the unsorted lot was coarser in microns than either the sorted or partially sorted, but the U. S. grade remained the same. Normal and stretched staple length was measured on 100 locks from each mill lot. Differences between sorting groups within grades were very small. The differences in length of top fiber within the grade lots were also very small. Scoured yields and yields of card sliver were very similar between sorting groups within grades. Scoured yields showed the expected increase as the grade dropped and card yields in general followed the same pattern.

Yields of top showed very little difference between types of sorting within grades. The tear (ratio of top to noils) shows the usual progression from finer to coarser wools and in all instances but one the unsorted wools have a higher ratio than do the partially sorted or sorted wools.

These results on the 1955 clip substantiate the previous findings on the 1954 clip that there may be only a slight, if any, advantage in sorting the Dubois wools.

Publications

Tailoring wool to textile needs. Agricultural Research 4(3): 3-5 September 1955.

5. Sex Differences in Fibers

ARS-APH

It was found that the percentage of ammonia nitrogen can be used as a good indicator of the condition of the untreated fiber in the skin of Merino and Hampshire sheep and Toggenburg goats. A difference was found to exist in the water content and the pH (acid or alkaline reaction) between the sexes of sheep and goats. This may bear some relation to certain preferences for ewes' wool over rams' wool.

6. Differences in Skin Metabolic Activity

ARS-APH

Macroscopic observations on the healing of skin wounds, covering a period of 20 months, brought out differences reflecting the varying metabolisms of the skins of two breeds of sheep and of one kind of dairy goat. Regeneration of the skin and the subsequent follicular and hair development proceed in a different fashion and at varying rates in Merino sheep, in Hampshire sheep and in Toggenburg goats. It seems that Merino skins undergo a development almost recapitulating that of foetal stages, the Hampshire skins proceed at a slower

rate, while the Toggenburg goats are longest in both healing and regenerating their skins and hairs. Scar tissue was hardly existent in Merinos and most pronounced and of longest duration in goats.

7. Establishment of Physiological Standards

ARS-APH

A contribution has been made towards the establishment of characteristic ranges of blood cell levels, hemoglobin content, sedimentation rates, and the morphologic picture of leucocytes of sheep and goats kept under Beltsville conditions throughout the seasons of the year. The purpose of these studies is to correlate certain phases of fiber growth as well as fiber shedding with the physiological activity of the animals.

8. Primeness in Skins of Fur Animals

ARS-APH

Microscopic studies of the skin of mink, rabbit, chinchilla and other fur-bearing animals have resulted in bringing out the importance of interrelated factors contributing to the state of primeness in animal skins. Such factors include the duration of the fiber growth cycle, the manner of follicle grouping, seasonal differences in the underfur guard hair ratio, the availability of energy-giving substances like fat and glycogen, and the distribution of skin glands. An awareness of the necessity for identifying the prime condition by the fur breeder will help to increase the production of pelts having the greatest usefulness and value.

Plans

This research work on wool and other animal fibers is being continued.

B. SHEEP BREEDING

1. Farm Sheep

ARS-APH

Animals used in the program on lamb and wool production under farm conditions include purebred and crossbred sheep of the Hampshire, Shropshire, Southdown, and Merino breeds, and a relatively new strain of Columbia X Southdale sheep. The success in production of lambs and wool is reported by ewe production indexes in which the largest figure represents the high production value.

The average ewe production index for purebred Hampshire was 59.8, for Shropshires 55.9, and Southdowns 53.7. The average ewe production indexes obtained in crossing of these three breeds were 63.7 for Hampshire ewes X Shropshire rams, 59.4 for Shropshire ewes X Hampshire rams, 59.0 for Hampshire ewes X Southdown rams, and 56.8 for Shropshire ewes X Southdown rams. The average ewe production index for all these three breeds was 59.7 for the group producing first cross lambs, and 56.4 for the group producing purebred lambs.

The 8 year average index for the groups producing first cross lambs was 66.7, and 57.9 for those producing purebred lambs; a difference of 15.2 percent in favor of the crossbreds.

Crossbred ewes bred to rams of a third breed involving the Hampshire, Shropshire and Southdown breeds were still more productive than purebreds and first crosses of these breeds. Crossbred ewes producing triple cross lambs of combined Southdown, Shropshire, and Hampshire inheritance averaged a production index of 68.5 as compared to 59.7 for ewes producing first cross lambs.

Beginning in the fall of 1955 half of the Merino flock of ewes were bred to Merino rams for the production of purebred lambs, and the other half of this flock was divided into three lots; one lot being bred to Hampshire rams, another to Shropshire rams, and a third lot to Southdown rams. These crossbred lambs will be compared with the purebred Merino lambs, as well as with other crossbred lambs of the mutton breeds. If these crossbred lambs compare favorably with the reciprocal crosses in which Merino rams were mated with mutton-type ewes, this type of lamb and fine-wool production should prove much more profitable to the commercial producer than would result from Merino breeding alone.

The development of the Columbia X Southdale strain of sheep is leading the way for the production of a breed of whitefaced farm sheep superior in the profitable production of both high quality lamb meat and wool. This year the ewes averaged a production index of 68.3 which exceeds that of any of the three purebred English mutton breeds by 14.2 percent. This flock is now approaching the fourth generation of inter se breeding since it was initiated in 1944. As soon as a sufficient number of fourth generation ewes are available they will be carefully selected and mated on a production as well as a conformation basis for the purpose of developing a profitable breed of sheep emphasizing both economical production of high quality lamb meat and the growing of heavy fleeces of wool having excellent manufacturing properties.

Publications

Hybrid Lambs Lead. Agricultural Research 4(7): 10-11. January 1956.

2. Range Sheep

ARS-APH

At Dubois, Idaho, systems of breeding for improvement of range sheep are being studied. Definite gains from selection are indicated by production records taken on weanling Rambouillet lambs in 1954 and 1955, as compared with similar records taken on comparable groups in 1948 and 1949. A gain of 17 percent was obtained in the weanling index of overall merit in a non-inbred group as compared with a gain of 12 percent in all inbred lines over this 6 year period.

Greatest gains were made toward more open faces and longer staple. This tends to confirm the high heritability estimates obtained for these traits. Only type score for which low estimates of heritability have been obtained, did not show improvement during the period. Relaxation of selection in a random sample of the non-inbred group did not lead to any marked deterioration in weanling traits. Averages for the offspring of the selected and unselected groups in 1955 were very similar except for more open faces and longer staple in the selected group. This would be expected from one generation of selection due to the high heritability and the emphasis on selection for these traits. In comparing the average record of the unselected offspring with the average records of the population from which their parents came it appears that slight regression or possible reduction due to environmental effects occurred for face covering and neck folds while condition score definitely improved. The latter change can be attributed either to environmental changes or to a change in scoring standards. Some slight deterioration with relaxed selection might be expected for face covering and neck folds because of the marked previous selection pressure that has been placed on these two traits. The results indicate that important weanling traits respond to selection and that such response is roughly similar to expectations from heritability estimates. These results provide a basis for making immediate improvements in sheep production through effective methods of selection. Studies are being continued to obtain more precise estimates of the response of each trait to selection, to develop more effective methods of selection, and to determine the limits to improvement of sheep by selection.

Publicationss

Improvement of Sheep Through Selection. Clair E. Terrill. Sheep and Goat Raiser 35(9): 8-9, June 1955.

Estrus in Range Ewe Lambs and Its Relation to Subsequent Reproduction. Earl L. Wiggins. Abstract. Jour. of Animal Science 14(4): 1260, November 1955.

Cull Those Dry Ewes. Earl L. Wiggins. National Wool Grower, Vol. XLVI (4): April 1956.

Vibriosis and Its Subsequent Effect Upon Reproduction in Range Ewes. Earl L. Wiggins. National Wool Grower, Vol. XLVI (5): May 1956.

Fertility in Range Rams. Earl L. Wiggins. National Wool Grower, Vol. XLVI (6): June 1956.

3. Systems of Breeding for Improvement of Range Sheep

ARS-APH

Lamb production data in 1953 and 1954 for various systems of breeding have been investigated at Dubois, Idaho. No adjustments for environmental effects were applied to any of the data but lamb weights were adjusted to the basis of an equal sex ratio and groups of lines were combined by giving equal emphasis to results from each line regardless of size of line. Crosses between inbred lines of sheep gave increases of 21 and 14% in 1953 and 1954 respectively, over the inbred line production. A system of recurrent selection of ewes, that is the selecting of high producing inbred ewes on the basis of their crossline offspring and in following years breeding such inbred ewes back to their own inbred lines, resulted in an increase of 9% in 1953 and 13% in 1954 as compared with the production of the stright inbred, unselected line ewes.

Topcross tests of rams from these same lines gave increases of 25 percent in 1953 and 33 percent in 1954 in pounds of lamb weaned per ewe bred over that of the inbred lines. The same rams mated to topcross ewes gave increases in pounds of lamb weaned per ewe bred of 18 percent in 1954 over that of the inbred lines. Comparison of all Rambouillet inbred lines with the non-inbred selected control group of Rambouillets showed increases in pounds of lamb weaned per ewe bred of 18 percent in 1953 and 17 percent in 1954 for the selected control group over inbred lines.

In the Targhee flock, topcross tests of all lines gave increases of 35 percent in 1953 and 17 percent in 1954 in pounds of lamb weaned per ewe bred over that of inbred lines. Topcross tests of rams from 3 lines for recurrent selection gave increases of 13 percent in 1953 and 28 percent in 1954 in pounds of lamb weaned per ewe bred over that of inbred lines. The same rams mated to topcross ewes increased lamb production 7 percent over that of the parent inbred lines.

In the Columbia flock, non-inbred ewes mated to inbred rams (topcross tests) weaned 5 percent and 27 percent more pounds of lamb per ewe bred in 1953 and 1954 than inbred ewes mated to the same rams in inbred matings. Crossline ewes (2 to 5 crosses) mated to inbred rams weaned 6 percent and 15 percent more pounds of lamb per ewe bred in 1953 and 1954 than inbred ewes mated to the same rams in inbred matings. It is obvious from these results that the mating system has a large effect on the economically important trait of pounds of lamb weaned per ewe bred. In sheep, increases from hybrid vigor appear to be larger for lamb production traits than for any other traits.

Plans

Investigation of systems of breeding for improvement of range sheep is being continued in several phases involving different methods of line formation, different methods of selection and different systems of breeding.

4. Influence of Breeding on Efficiency of Gains in Range Sheep ARS-APH

Efficiency of gain tests on individual lambs were initiated in January 1956 at Dubois, Idaho, in cooperation with the Idaho Agr. Expt. Sta. Thirty-two Rambouillet ram lambs and 16 Rambouillet ewe lambs were tested in six 14-day periods on pelleted rations consisting of 1/8 oats and 7/8 alfalfa hay for ram lambs and alfalfa hay for ewe lambs. Data were collected on individual feed consumption, weight and efficiency in addition to a variety of records at start and end of test and at shearing time. Comparison of the lambs individually fed with similar lambs wintered at Mud Lake indicates that the ram lambs individually fed were definitely superior to the group-fed ram lambs in body weight, grease fleece weight, clean fleece weight, type and condition at shearing time. The ewe lambs individually fed excelled the group-fed ewe lambs by smaller amounts for most traits but were not different in type.

Plans

Data will be analyzed to determine optimum length of the test period, heritability of rate of gain and efficiency, and relationships to other traits. Individual feed tests will be continued in 1957 and rams tested in 1956 will be used in breeding in 1956-57 in order to determine the efficiency of their progeny.

5. Testing of Inbred Lines of Sheep Through Topcrossing ARS-APH

Topcross testing of inbred lines of sheep was initiated in 1954-55 at Bozeman in cooperation with the Montana Agr. Expt. Sta. Two sires were tested from each of 3 Rambouillet lines, 1 Targhee line, and 1 Columbia line, developed at Bozeman, and from each of 3 Rambouillet lines, 2 Targhee lines, and 2 Columbia lines developed at Dubois. Two Rambouillet rams, 1 Targhee ram and 1 Columbia ram from commercial breeders were also tested as were the same numbers of rams from non-inbred selected control groups developed at Dubois. All rams from Rambouillet and Targhee inbred lines were picked at random while all other rams were selected on the basis of individual merit.

Preliminary results have been approximately adjusted for environmental effects on the basis of 1955 Dubois factors for each breed. The results in Rambouillets indicate a distinct superiority of the offspring of the selected control rams in comparison with the average of offspring of rams from the six inbred lines and offspring of breeders' rams. Weanling indexes for the three groups based on weight, type, condition, staple length, face covering and neck folds were 148, 134 and 132, respectively. Offspring of selected control rams excelled in weight, type, condition, open face and freedom from neck folds while offspring of inbred rams exceeded the former very slightly in staple length and fineness of wool. Offspring from breeders rams were lowest in every trait except face covering

for which they were slightly more open than offspring of inbred rams and fineness for which they were the same as offspring of selected control rams.

The random choice of inbred rams places them at a definite handicap in relation to the other two groups because considerable variability still exists between individuals in these inbred lines. Results from Targhee rams were similar to Rambouillet results with weanling indexes of 154, 146 and 138, respectively, for offspring of the selected control ram, offspring of rams from 3 inbred lines and offspring of the breeder's ram. Offspring of the selected control ram excelled in weight, staple length, open face, freedom from neck folds and fineness of wool but were poorest in type and intermediate in condition. Offspring of the breeder's ram excelled in type, were intermediate in condition and were poorest in every other trait. The handicap of random choice of inbred rams exists in this breed also.

Results from Columbia rams were different in that offspring of the breeder's ram excelled the other two groups for overall merit on the basis of a weanling index composed of weight, type, condition, staple length and wool fineness. The index values were 132, 127 and 125, respectively, for offspring of the breeder's ram, offspring of inbred rams from 3 lines and offspring of the selected control ram. Offspring of the breeder's ram excelled in weight, condition and fineness, were intermediate in face covering and were poorest in type, staple length and neck folds. Offspring of inbred rams excelled in type and open face and were intermediate in weight, condition, staple length, neck folds and fineness.

The results tend to show encouraging possibilities for the selection of commercially useful lines from the Rambouillet and Targhee breeds and high merit in the selected control groups in these breeds. Selected control groups have been recently formed in Targhees and Columbias and their merit is not likely to be greatly different from the merit of inbred lines at this time. Results in Columbias indicate lower merit in inbred and selected control rams than is available in breeders' rams, at least in the particular lines tested.

Plans

In 1956-57 the procedure will be altered by using selected rams from inbred lines of Rambouillets and Targhees. It is planned that each line will be tested for at least two years and preferably for three years.

6. Navajo Sheep

ARS-APH

At Fort Wingate, N. M., Navajo sheep are being compared with crossbreds obtained from crossing improved rams of established breeds with Navajo ewes. Over a six year period Navajo ewes weaned 87 percent of twin lambs and 89 percent of single lambs as compared with 78 and 86 percent respectively from

crossbred ewes. The advantage of the Navajo sheep in rate of lamb production is largely offset by a deficiency in lamb weight. Navajo ewes weaned an average of 86 pounds of lamb per ewe for twins and 54 pounds for singles compared to 84 and 55 pounds, respectively, for crossbred ewes. Average weaning weights per lamb were 50 and 59 pounds for Navajo twins and singles and 54 and 64 pounds, respectively, for crossbreds. There was no evidence in the weaning weights in different years that Navajo ewes survived drought conditions better than crossbred ewes. The adaptability of the Navajo strain to rigorous semi-arid conditions with their high rates of reproduction and survival make the Navajo strain valuable for further selection and crossbreeding work in spite of their small size, poor mutton conformation and low fleece value.

A line of crossbred coarse woolled sheep has been produced at the Fort Wingate Sta. which produces quarter blood wool suitable for Navajo hand weaving. This line combines hardiness and adaptability of the Navajo strain with desirable wool qualities and mutton conformation of improved breeds. One of the objectives of this project is to provide breeding rams for Navajo stockmen who produce weaving wool. An index has been constructed to aid in improving this crossbred line by selection at weaning age. This index should lead to improvement in weaning weight, body type and desired fiber diameter, with no change in condition and percent of medullated fibers, while staple length will probably become slightly shorter. Further work to improve this index includes obtaining more reliable estimates of heritability, and more adequate information regarding both economic values and relationships between weanling traits and traits at more mature ages.

Publications

Some Aspects of Twin Versus Single Lambs of Navajo and Navajo Crossbred Ewes. George M. Sidwell. Jour. of Animal Science 15(1): 202-210, February 1956.

7. Improvement of Navajo Reservation Sheep

ARS-APH

A project was initiated to teach the Navajo Indians the value of a consistent breeding and selection program in their flocks of sheep on the reservation.

Four hundred average reservation ewes were assembled at the Southwestern Range and Sheep Breeding Laboratory. These ewes were divided at random into four groups of 100 ewes each, and were range bred respectively to rams of Targhee, Rambouillet, Coarsewool (1/4 blood), and average reservation breeding. This last group will serve as a control or genetically stabilized group, and all culling and replacements will be made at random.

A limited amount of information is now available on the two year old ewe progeny of the original reservation ewes. In all traits (staple length, body weight, grease and clean fleece weights, and wool grade) except clean fleece weight, the unselected or control offspring were superior to the dams. This no doubt indicates that a more favorable environment prevailed at the Laboratory than under reservation conditions. When an adjustment for sex is made on the rams, the traits of the offspring in each group in which superior sires were used fall almost half-way between the sire and the dam for the traits grease fleece weight, clean fleece weight, and grade. A sex adjustment is not needed for staple length and this trait is about half-way between the values of the sire and the dam. Body weight however was not greatly influenced by the sire. This trait is more influenced by environmental conditions than any of the other traits listed.

8. Evaluation of Traits for Sheep Improvement

ARS-APH

Investigations of new traits are needed to determine whether their addition to routine selection procedures would lead to greater progress in over-all merit. One phase of these investigations involves estimates of heritability to determine how much gain from selection can be expected for each trait. Estimates of heritability were obtained for 34 fleece and body traits of yearling Targhee ewes at Dubois. High average estimates of heritability ranging from 0.67 to 0.53 were found for unstretched length, handle, stretched length, matching yield and clean fleece weight. Moderately high average estimates of heritability, ranging from 0.43 to 0.29 were found for clean fleece yield, face covering, staple length, fleece grade, noil yield, body weight, weanling index, matching grade, percent noils, diameter, diameter grade, type, grease fleece weight and breech grade. Side grade, condition, ease of carding, neck folds, and variability of diameter had moderately low average estimates of heritability ranging from 0.24 to 0.20. Very low average estimates of heritability ranging from 0.16 to -.09 were obtained for unstretched and stretched length, top yield, percent top card yield, breech grade score, coefficients of variation of unstretched and stretched length and percent of stretch for length. These results indicate that handle or softness of wool and possibly clean yield should be considered along with fleece weight, staple length, face covering, weaning weight, type, condition and other lamb production traits in selecting for improvement of Targhee sheep. Additional estimates of heritability are being obtained along with estimates of economic importance for various traits which may be used in selection.

C. SHEEP FEEDING AND NUTRITION

1. Ruminant Bloat

ARS-APH
& ADP

Extensive studies on ruminant bloat have involved the use of both sheep and cattle and has involved direct cooperation with WU, ADP and FC of ARS, and with the New York State Veterinary College and Maryland Agr. Expt. Sta. Progress can be reported on the following phases of the work:

(a) Physiological and Pharmacological Studies - Studies have been conducted to determine the effect of administration of alfalfa saponin to sheep. Bloat symptoms have been produced in sheep following intraruminal and intravenous administration of the saponin under appropriate conditions. It has been shown by physiological and pharmacological studies that intravenous administration of the alfalfa saponin (1 g. doses) can: (1) Prevent eructation (belching) in sheep by its actions on the esophagus and other organs; (2) cause lack of rumen tone; (3) have a pronounced effect on the respiratory center and can cause respiratory failure; (4) affect heart action and blood pressure; and (5) result in toxic effects other than those listed above. Intraruminal administration of large doses of alfalfa saponin to sheep (50 g.) results in similar effects. Smaller doses (15 to 30 g) results in reduced ruminal motility in some sheep and has little apparent effect in others. Administration of 1 gram of the alfalfa saponin into the duodenum of sheep results in an immediate cessation of all rumen motility except that associated with eructation. It has been possible, therefore, to separate the contractions of the rumen that are associated with eructation from those associated with mixing of the rumen contents. With this and other techniques it has been shown that the rumen contractions associated with eructation are stimulated by gas pressure rather than by the presence of fibrous material and that apparently these contractions are controlled by different nerve impulses or by a different nerve network than the regular contractions. Legume press juices have been shown to effect ruminal motility in a manner similar to that of alfalfa saponin, however, some saponins isolated from non-legumes have not affected ruminal motility.

In-vitro studies indicate that alfalfa saponins may play an important part in the formation of and the stabilization of frothy ruminal contents, but that other factors are necessary for the production of frothy bloat in addition to the saponin. Mild experimental "frothy" bloat has been produced in sheep by the use of legume press juices and by the use of a combination of water soluble protein, alfalfa saponin and plant sugars. Observations during this type of experimental bloat have indicated that the ruminal contractions associated with eructation increase in frequency and even in strength while the "major" ruminal contractions

can be markedly reduced in strength. The gross and histological lesions resulting from toxic levels of alfalfa saponin have been determined in sheep.

(b) Fermentation in the Rumen - There was some expansion of the basic fundamental work on bloat of ruminants (coop. California, Cornell, Maryland, Minnesota, Mississippi, and Wisconsin Agr. Expt. Stas.). Radioisotopic studies have been applied for the first time to bloat studies on the fermentation in rumens of bloated animals and an artificial heart and lungs have been developed for physiological studies connected with bloat. The efferent nervous influences of the entire esophagus, including the sphincters, have been worked out with decerebrated sheep. The effects of changes of the position of the sheep on the process of eructation have been determined. Some basic work has been done on the isolation from alfalfa of organic acids which produce "bursts" of gas as they are decarboxylated by paunch organisms. These have been identified by chromatography. This may be the reason for rapid froth production with legumes as this phenomenon is absent or less extensive in grasses. This work may be an important contribution to the bloat problem. In studies on the effect of protein level of forage on incidence of bloat, the disease could be produced in a severe nature by the addition of egg albumen to ground alfalfa. The rate of eructation was normal or slightly accelerated but the amount of gas eructed per belch did not suffice to prevent bloat.

(c) Feedlot Bloat and Bacteriological Studies - A diet has been developed that will result in frothy bloat in cattle. A difference has been noted among animals in their susceptibility to bloat. The incidence of and severity of bloat in relation to the time the animals received the bloat producing diets was increased materially. This increase in the incidence of bloat with time can not be correlated with any of the existing theories for the pathogenesis of bloat. It has been found, however, that certain changes in the nature of the ruminal contents is correlated with the incidence of this type of bloat. A highly significant correlation between the percentage of encapsulation of microorganisms and the occurrence of bloat was noted. Over a 16 week period during which the incidence of bloat steadily increased, negative correlation was found between the per cent of ruminal contents which settled out into a liquid phase and the incidence of bloat. Bacteriological and biochemical studies conducted during this period indicated that the metabolic activity of the rumen microorganisms did not reach an equilibrium for a considerable length of time after the cattle were started on the bloat producing diet. This finding is significant in that it is generally believed that the metabolic activity of rumen microorganisms reaches an equilibrium very rapidly following a dietary change.

An in-vitro test for studying the stability of froth of ruminal contents indicated that methyl-silicone preparations are effective in breaking froth, but that they may have to be used in larger quantities than often recommended. Turpentine and kerosene are very effective in breaking frothy ingesta in in-vitro tests. A number of detergents proved to be ineffective in reducing the formation of froth.

(d) Chemical Composition of Legumes in Relation to Bloat - The readily fermentable sugars of legumes may result in rapid gas formation and thus contribute to the pathogenesis of acute bloat. In studies on the carbohydrate content of alfalfa and Ladino clover forage it was found that the total sugar content of Ladino clover may be as high as 10 to 12 percent (dry matter basis) during the bloating stages of growth. The total soluble sugars vary according to the season of the year and with the time of day. The total soluble sugars content can also be affected by fertilizer application.

Plans

Work on all phases of ruminant bloat will be continued. (See Proposals for Committee Consideration)

Publications

Studies on Biochemical, Physical, and Bacteriological Factors Involved in Feed Lot Bloat. Don R. Jacobson and Ivan L. Lindahl. Uni. of Maryland Misc. Pub. 238, June 1955

Physical Properties of Paunch Juice Which May Contribute to Bloating. R. E. Nichols. Veterinary Medicine 51, No. 2, pp. 47-52, February 1956.

The Effect of Protein Level on Rumen Volatile Fatty Acids. N. S. Woodhouse, R. F. Davis, and G. H. Beck. Misc. Pub. No. 238, Maryland Agr. Expt. Sta., June 1955.

Physiological Effects of Insufflation of the Stomach. R. W. Dougherty, D. C. Meredith, and R. B. Barrett. Amer. Jour. Vet. Research, Vol. 16, 1955.

Changes in Temperature of Reticulo-Ruminal Content Following the Drinking of Water. R. D. Dillon and R. E. Nichols. Amer. Jour. Vet. Research, Vol. 16, 1955.

Cinefluorographic Studies of the Ruminant Stomach and of Eructation. R. W. Dougherty and C. D. Meredith. Amer. Jour. Vet. Research, Vol. 16, 1955.

A Sampling Tube for Rumen Fluid. R. E. Nichols. Amer. Jour. Vet. Research, July 1955.

2. Use of Non-Protein-Nitrogen for Sheep

ARS-APH

Digestibility and nitrogen retention trials were conducted in which the value of ammoniated molasses and urea as protein precursors were compared with linseed oil meal as a protein supplement. The basal diet was 53 percent grass hay, 10 percent alfalfa meal and 10 percent molasses with corn. The protein carrier being adjusted so that the diet contained approximately 11 percent crude protein or protein equivalent. The comparisons were: (a) Control, 7 percent linseed oil meal and 10 percent blackstrap molasses; (b) 0.75 percent urea and 10 percent blackstrap molasses; (c) 3 percent oil meal and 10 percent ammoniated molasses; and (d) 0.3 percent urea and 10 percent ammoniated molasses. The digestibility of all constituents except crude protein was similar on the diets. The digestibility of crude protein was highest in diet (a). The percentage of the nitrogen fed that was retained by the sheep was as follows with the control diet given an arbitrary value of 100: (b) 80.1; (c) 95.8; and (d) 80.5.

In view of reports that feeding of ammoniated molasses could lead to nervous disorders and toxic effects, a toxicity experiment was conducted in which large quantities of ammoniated molasses were administered to four sheep. The only other feed offered these sheep was grass hay, ad libitum. These animals were given 200 grams per day of molasses for 10 days, 400 grams per day for another 10-day period, 600 grams per day for an additional 10 days, and 800 grams per day for a period of 25 days. One of these animals refused to eat, developed diarrhea and appeared to be listless on the high level of molasses. No nervous disorders were detected at any time during the experiment although the animals were subjected to vigorous exercise at intervals. The animal that went off feed was sacrificed, but the other three animals displayed no adverse symptoms after removal from the experiment. The drenching of two animals each with two liters of the molasses product did result in toxic effects but not in nervous disorders. It would appear that different lots or preparations of ammoniated molasses can vary considerably in their toxic actions.

3. Effect of Pelleting on Feed Utilization by Fattening Lambs

ARS-APH

Prior experiments had shown that the rate of and efficiency of gain could be increased by pelleting diets for feeder lambs. In order to elucidate some of the factors concerned with the utilization of pelleted feeds, the effect of pelleting on the composition of 7 diets and on the digestibility of the nutrients by lambs was determined. Pelleting usually reduced the moisture content of feed mixtures even when steam or water was used in the process and also tended to increase the ether extract and to decrease the crude fiber. Pelleting also tended to increase the digestibility of the ether extract fraction and to lower the digestibility of the crude fiber but had little or no effect on the digestibility of the other constituents. The increase

in the percentage of ether extract and in its digestibility was most pronounced with diets that contained appreciable amounts of alfalfa hay or meal. The increase in the amount of digestible ether extract appears to be due to an increase in the non-fat portion as the amount of digestible gross energy was not increased by pelleting. In two different trials the apparent utilization of carotene was increased by pelleting diets containing alfalfa meal as the source of the carotene.

Plans

Work is in progress to determine the effect of pelleting on various constituents of the ether extract portion of alfalfa containing diets. Experiments are planned in which the effect of pelleting of various roughages on the utilization of the nutrients will be compared with feeding the roughages in a ground and in an unground state, and to determine the effects of feeding of pellets to sheep on a long time basis.

Publications

Effect of pelleting on feed utilization by fattening lambs.

Ivan L. Lindahl and R. E. Davis. Feed Age. 5: 36-40. September 1955.

Effect of pelleting on the digestibility of lamb diets.

Ivan L. Lindahl and R. E. Davis. Jour. Animal Sci. 14: 1215
(Abstract) November 1955.

4. Effects of Diet Composition on Reproduction of Ewes

ARS-APH

A group of crossbred ewes were divided into two groups after the breeding season. One group was fed a diet composed of Number 2 alfalfa hay while the second group was fed a diet composed of timothy hay plus 1.0 lb. of supplement per ewe per day. Approximately 6 weeks before the ewes were due to lamb, both groups were given an additional allowance of a 75-25 percent mixture of oats and wheat bran. This was gradually increased until two weeks before lambing time when the ewes received 1 pound of the oats and bran mixture per day. The lambs from both groups were allowed the same creep feed and when the lambs were 1 month of age the ewes and lambs from both groups were turned on a grass pasture.

There was no significant differences between the number of lambs born, the birth weight of the lambs and the pre-lambing weight gains of the ewes, but the difference in the weight of the lambs at 8 weeks of age was significantly greater from the ewes that received the alfalfa diet. The ewes fed the alfalfa hay lost considerably less weight during the first month following lambing than the ewes on the supplemented timothy. The average wool clip from the ewes on alfalfa was also 0.9 lb. heavier than that from

the ewes on the supplemented timothy, while the difference in the wool weight of the two groups during the previous year was only 0.2 lb. in favor of the first group. The results indicate that factors other than the usually recognized ones have an effect on the production of ewes and the growth of their lambs. The ewes on both diets received more energy, digestible protein, carotene, Ca and P than the requirements recommended by Morrison for pregnant and lactating ewes.

5. Goat Nutrition Investigations

ARS-APH

Ten reversal trials were conducted with Toggenburg does to determine the requirements for crude protein and complexity of concentrate mixtures when fed with different types of roughages. A concentrate of crushed oats (12.3 percent protein) was compared with complex concentrates (16 percent protein). Roughages used were alfalfa hay, mixed hay of one part alfalfa and 2 parts timothy, or mixed hay and grass pasture. In each series of trials the milk production was greater with the complex concentrate than with simple concentrate, but the differences were not great. Preliminary results indicate that good milk production can be obtained with a simple concentrate when fed with good grade roughage or pasture but that a more complex mixture and higher levels of protein may be required for maximum production when poorer grades of roughages such as mixed hay are fed.

Investigations on the nutritive requirements for the growth and development of kid goats showed that 1 percent of sulfur added to the concentrate mixture fed to kid goats does not afford adequate protection against coccidial infection. Kid goats fed a complex concentrate consisting of corn, barley, linseed oil meal and molasses (16 percent protein) gained slightly more than those receiving a concentrate of crushed oats (12.3 percent protein). Both groups were fed alfalfa hay and allowed to graze on a grass pasture.

Plans

Continue this work to obtain more conclusive information on the nutritive requirements of does and kid goats.

Publications

Milk Goats. C. G. Potts and V. L. Simmons. Farmers' Bulletin No. 920, U. S. Department of Agriculture, October 1955.

6. Radioactive Sulphur Studies

ARS-APH

It has been shown that rumen microorganisms from sheep were capable of utilizing sulfur from inorganic sulfate for the synthesis of cystine and methionine in vitro. In these studies the fermentation flasks were flushed continuously with carbon dioxide to maintain

anaerobiosis, to stir the mixture and to carry away fermentation gases. A qualitative determination of the radioactivity was made of the gases exhausted and they were found to contain considerable amounts of radio sulfur in the form of hydrogen sulfide. In incubations with cystine as the source of labeled sulfur, more than 80 percent of the total dose of radioactivity was lost in the evolved gases over a two hour period.

Since rubber was found to absorb hydrogen sulfide, an all glass closed artificial rumen was devised to prevent losses of radioactivity. Studies are now in progress to determine the extent of conversion of inorganic sulfate sulfur to organic sulfur under these conditions. In the incubation studies with S^{35} -L-cystine, radio-methionine was synthesized and incorporated into the alcohol insoluble fraction of the fermentation mass.

Plans

Investigations are being continued on the utilization of sulfur and on its conversion to cystine and methionine.

D. SHEEP PHYSIOLOGY

1. Relation of Estrus in Range Ewe Lambs to Later Reproduction ARS-APH

At Dubois, Idaho, information on the occurrence of estrus was obtained on 2386 range ewe lambs by allowing vasectomized rams equipped with marking harness to run with the ewe lamb band during the winter. Some estrual activity was observed from September to late February but the majority of the lambs had their first heat from the middle of November to the last of December. The percentage of lambs having one or more heat periods their first winter were 15.9, 14.5 and 15.0 for lambs born in 1952, 1953, and 1954, respectively. Of the 138 lambs born in 1954 that were in heat, 61.6 percent had one heat period, 24.6 percent had two, 8.0 had three, 3.6 had four and 2.2 percent had five heat periods. Ewe lambs which came in heat tended to be less inbred, and to excel in open face, condition score, weanling body weight and yearling body weight as compared with ewe lambs which did not come in heat. Ewe lambs which came in heat had greater lamb production at two years of age than lambs which did not come in heat in the Rambouillet and Targhee breeds but not in the Columbia breed where only 9 ewe lambs were included in the former group.

Plans

This work is being continued to find ways of predicting lamb producing ability at an early age.

Publications

Estrus in Range Ewe Lambs and Its Relation to Subsequent Reproduction. Earl L. Wiggins. Jour. of Animal Science, Vol. 14, No. 4, page 1260. November 1955

2. Effect of Season on Skin and Fiber Follicles

ARS-APH

Procedures have been worked out for the periodic examination throughout the year of the skin and fiber follicles, as well as the blood supply of the follicles, of Merino and Hampshire sheep and Toggenburg goats. These animals were selected as examples of practically non-shedding and shedding animals. Simultaneously with the collection of skin and fiber samples from the live animals, techniques for the study of the blood of these animals are being employed to ascertain any possible changes in the blood itself which may be related to season and perhaps to fiber growth. In addition, tests are being conducted to determine whether or not physiological differences may be found in the fibers of the animals studied.

Plans

This work is being continued.

E. SHEEP MANAGEMENT

1. Effect of Shearing, Light and Temperature on the Rate of Wool Growth and the Reaction of Sheep to Hot Environments

ARS-APH

Experiments with rams over a period of six months indicate that shearing sheep once a month does not increase the rate of wool growth over the rate of wool growth on sheep sheared once in six months. There was no difference in wool growth between sheep subjected to a daily routine of being kept in darkness 17 hours and in daylight 7 hours of each 24-hour period as compared with sheep kept under normal seasonal light variations. Sheep shorn once a month showed no trend in the rate of their growth of wool accompanying the seasonal temperature and light changes under which they were kept. Marked differences have been noted in responses of different sheep to high environmental temperatures.

2. Development of Scourable Sheep-Branding Fluids

ARS-APH

Tests of the durability of various branding fluids on sheep are being done in cooperation with the Idaho Agr. Expt. Sta. at Dubois, Moscow, Caldwell and Aberdeen, Idaho. In 1955-56, four kinds of branding fluids were tested at all four locations. An additional set of four branding fluids was tested only at Dubois with formula G included in both sets. Four colors (red, black, green, and blue) of each kind of branding fluid except Australian (black not produced) were tested. Legibility of brands applied after shearing in 1955

was scored 6 months and 12 months later. Results from tests of seven kinds of branding fluids at Dubois on fine-wool sheep definitely show that the two USDA scourable branding fluids (formula G and formula I) are exceeded in legibility at 6 months by only two kinds of the branding fluids tested, both of which are unscourable. The two fluids which showed superior legibility are commercial branding fluids in common usage which have different types of unscourability. The scourable Australian branding fluid gave the poorest legibility of the seven kinds tested at Dubois and was also poorest at the other three locations. A third unscourable commercial branding fluid tested at Dubois ranked sixth for legibility of three colors but was excellent for black. The scourable English branding fluid tested at Dubois appeared to be somewhat poorer in legibility than formulas G and I. Formula I ranked slightly below formula G in legibility on the average for over-all colors but appears to be more legible than formula G for two colors.

Plans

Further analysis of the 1955-56 data will provide information on the effects of grade of wool and geographical location on legibility of various kinds and colors of branding fluids. A test of the durability of the most legible commercial branding fluid (unscourable) and the three most legible scourable branding fluids (formula G, formula I and English) is being made in 1956-57 at all four locations. It is hoped that mill tests through the top stage can be run in 1957 on the best two unscourable fluids and the best three scourable fluids to obtain a definite check on the ease and completeness of removing the various branding fluids from wool.

3. The Response of Targhee Sheep to Environment

ARS-APH

The response of Targhee sheep at Moscow, Idaho, is being tested in cooperation with the Idaho Agr. Expt. Sta. Weaning weights at Moscow tend to be slightly lower than those of comparable sheep at Dubois. Data from this small flock from 1952 to 1955 indicate that body weights, grease fleece weights and clean fleece weights of yearling rams and yearling ewes are much larger under the environment at Moscow than at Dubois, while fleece fineness is similar. The percentage increase over weights at Dubois was small for 1953 but the average percentage increases over the four-year period were 51 percent and 35 percent for body weights, 39 percent and 47 percent for grease fleece weights and 51 percent and 60 percent for clean fleece weights of yearling rams and yearling ewes, respectively. Fall weights of mature ewes at Moscow were much higher than at Dubois but grease fleece weights of mature ewes tended to be slightly lower. Cooperative workers indicate that this breed has shown considerably greater promise for use as a farm sheep during the last couple of years of the experiment than during the first year. They also indicate that Targhee sheep are very good from the wool production standpoint and should be fairly good for meat production if good individuals are selected for the breeding flock.

Plans

The project is scheduled to be revised at which time changes may be made.

4. Herded Versus Fenced Ranges

ARS-APH

During the past twenty years, sheep numbers in New Mexico have declined about 58 percent. In areas where herding is still practiced the reduction in numbers has varied from 62 to 85 percent, while in areas where the range has been fenced, the reduction in numbers has been only 15 percent. This change in management has not only reduced operating costs and eliminated the problem of finding reliable trained herders, but has increased both wool and lamb production. Due to rising operating costs at the SW Range and Sheep Breeding Laboratory, it appears that it will be necessary to change from the present herding system to fenced ranges. This change in management should provide a comparison of herded versus fenced systems of operation.

5. Moisture Losses from the Skin of Sheep (Coop. Committee on Bioclimatology, Johns Hopkins University)

ARS-APH

Studies have been initiated to determine the moisture loss from the skin of sheep at high temperature and humidity. This work was undertaken to investigate the heat loss mechanism of sheep in respect to their adaptation to hot and humid conditions. In preliminary studies the moisture losses from the skin of four sheep were determined at temperatures of 80°F and 60 percent relative humidity and at 105°F and 60 percent relative humidity, when the animals had a full coat of wool and when they were shorn. In these studies the moisture losses were determined on skin areas of 10 sq. cm. and at 4 locations on the body. No moisture losses were detected at 80°F, but a moisture loss of 250 to 500 grams per sq. meter per hour was observed at 105°F. Since in a briskly perspiring man the moisture loss is 400 to 600 grams per sq. meter per hour, it appears that moisture loss at high temperatures is an important part of the heat regulating mechanism of sheep. No appreciable differences were found between the shorn and unshorn sheep.

F. SHEEP DISEASES AND PARASITES

1. Poisonous Plants

ARS-ADP

Studies on poisonous plants have been reactivated in the laboratory at Logan, Utah, and the relationship of plants to three diseases found in western sheep are being studied. These are a "monkey-faced" condition in newborn lambs of Idaho, an encephalitis-like condition in range sheep of Nevada and Idaho, and a scabby soreness of the teats, vulva, and nose of ewes in Utah. Feedings of a plant called

"wild carrot" of the Cymopterus genera have resulted in reproduction of the sores of the woolless areas such as the teats, vulva, and nose when the sheep were kept in the sun. Feedings of another plant, Cordalis caseana, in connection with the "monkey-faced" lamb condition are being made to range ewes during various periods before and after breeding because bands of 8000 ewes followed through the lambing season in 1955 had 3 percent of lambs with malformed heads and 155 additional ewes had macerated malformed feti in their womb, and this plant was an appreciable part of the plants grazed. Toxicity studies are under way for Halogeton to learn the diagnostic symptoms and lesions of poisoning by this plant. When calcium carbonate was given in proportion of 1/8 of the amount of Halogeton fed, the sheep were protected.

Plans

The work will be continued on the relationship of plants to these three sheep diseases of unknown cause. Feeding tests and chemical studies will also be made on other plants under suspicion on which information as to toxicity is needed. (See Proposals for Committee Consideration)

Publications

Plant Poisoning of Livestock. Wayne Binns. National Woolgrower, June 1956.

Sumac as Poisonous Plant. Edward A. Moran. Better Goatkeeping, April 1955.

Stock Poisoning from Domestic Plants. Edward A. Moran. Better Goatkeeping, December 1955.

2. Toxicology of Insecticides for Sheep

ARS-ADP

The effects on the health of sheep of various insecticides being used and of those showing promise from research by entomologists are being studied to develop full information on the symptoms, lesions, safe doses, and toxic doses. These include those being used on sheep and also on sheep forage. Several hundred abdominal surgical operations were performed on sheep and cattle to obtain fat required for tissue residue studies in connection with Public Law 517. The cholinesterase activity of normal blood of sheep was determined in connection with work under way on one group of insecticides known as the organic phosphorus compounds. The toxicology studies were expanded during the year to include some work on herbicides. The toxicology of delrad for control of algae in ponds, lakes, and tanks was determined and delrad was found safe. The toxicology of pentachlorophenol was determined so as to know the symptoms and lesions produced by this commonly used cotton

defoliant. It was shown that this method of defoliation of cotton did not cause the cottonseed cake and meal to become poisonous for sheep. The acute toxicity for sheep was determined for nine relatively new and promising insecticides.

Plans

The toxicology studies will be continued to determine additional information on insecticides now approved and used. Surgical operations will be performed to collect abdominal fat for residue studies on the sheep being fed for toxicology studies. New, promising insecticides will be studied for toxicity.

Publications

The Acute Toxicity of Chlorinated Hydrocarbon and Organic Phosphorus Insecticides to Livestock. R. D. Radeleff, G. T. Woodard, W. J. Nickerson, and R. C. Bushland. Tech. Bul. 1122, U. S. Dept. of Agriculture, November 1955.

Toxicological Problems in the Use of Systemic Insecticides. R. D. Radeleff and G. T. Woodard. Jour. Economic Entomology, Vol. 49, No. 1, pp. 89-91, February 1956.

The Past, Present, and Future of Systemic Parasitocides. R. D. Radeleff and G. T. Woodard. Veterinary Medicine, Vol. 51, No. 4, pp. 152-154, April 1956.

3. Vibriosis of Sheep

ARS-ADP

Work was initiated on vibriosis of sheep at Beltsville, Maryland, and in cooperation with the Montana, Utah, and Colorado Agr. Expt. Stas. Virgin ewes bred to rams infected with pathogenic *Vibrio* conceived and lambed normally as did the control virgin ewes bred to non-infected rams. A group of the above ewes bred to non-infected rams were fed infective ground placenta, vaginal discharges, and fetal tissues during the first part of their fifth month of pregnancy. Of these ewes, 74 percent aborted as a result of *Vibrio* infection on an average of 12.4 days following feeding. Pregnant ewes also aborted when given intravenous injections of either sheep or cattle strains of pathogenic *Vibrio*. Similar experiments were conducted using catalase-negative and H_2S positive *Vibrio* which are considered nonpathogenic. Virgin ewes bred to rams infected with nonpathogenic *Vibrio* conceived and lambed normally as did the controls bred to non-infected rams. Pregnant ewes either aborted or gave birth to abnormally weak lambs when given intrauterine injections of 1 cc. nonpathogenic *Vibrio* suspensions. Ewes 3 and 4 months pregnant given heavy cultural suspensions orally gave birth to normal lambs at term.

Two groups of ewes, one fed infected tissues and the other that had aborted in 1955, were rebred to normal rams in 1956. A control group of normal susceptible ewes were also bred to clean rams at the same time. All were exposed to *Vibrio* infection during the early part of the fifth month of pregnancy by feeding ground placentas, exudates, and intestines from aborted fetuses. Less than 10 percent of the two previously infected groups of ewes lost their lambs; whereas, 76 percent of the controls lost their lambs. This strongly indicates that ewes develop and maintain a high degree of immunity for at least one year following infection.

Preputial cultures were made of rams from herds with, and without, a history of vibrionic abortions. Of 1088 rams sampled, cultures of the nonpathogenic type of *Vibrio* were isolated from 92. A serological study of the nonpathogenic type of *Vibrio* indicates that it does not cross-agglutinate with positive sera from animals sensitized to the pathogenic type of *Vibrio*. Further serological studies indicate that it may be similar to the nonpathogenic type of *Vibrio* commonly found in bulls. The pathological strains of *Vibrio* isolated from sheep have been classified into serological groups by cross-agglutination reactions made with whole culture antigens. Preliminary work on cross-agglutination tests with these strains indicates that they may be serologically similar to some pathogenic strains found in cattle.

Plans

Work is being continued to determine the sources of pathogenic *Vibrio* infection in sheep and the relationship between *Vibrio* isolated from cattle and sheep.

4. Bluetongue in Sheep

ARS-ADP

Research has been conducted at the Denver Animal Disease Research Laboratory to determine the presence of bluetongue virus and the antigenic type in the blood or tissue of sheep and cattle in the various States. Finding a place to obtain sheep that were susceptible to bluetongue made it possible to conduct a great number of tests and to make more bluetongue virus isolations.

Sheep blood samples were received from Arizona, California, Colorado, Indiana, Louisiana, Missouri, New Mexico, Oklahoma, and Texas; representing outbreaks of suspected bluetongue in 45 flocks. The virus was isolated for the first time from the blood of sheep in New Mexico and Oklahoma. Test by inoculation of susceptible sheep with the sheep blood samples from Indiana and Louisiana were negative for virus isolations. Reported infections of bluetongue in two flocks of sheep in western Minnesota were investigated and found to be negative.

Eight bluetongue virus isolates have been adapted to chicken embryos. Other tests for virus adaption are in progress. The serum neutralization test has been conducted on chicken embryos to determine the presence of specific antibodies in the blood of sheep to known bluetongue virus. It will be necessary to continue the studies to determine the true value of the test.

Plans

Examinations will be continued to determine the presence of bluetongue virus and the antigenic type in the blood or tissue of sheep and cattle in the various states. Work will be continued to determine the diagnostic value of a serum neutralization test conducted on chick embryos for the presence of specific antibodies in the blood of sheep to known bluetongue virus.

5. Resistance to Intestinal Threadworms in Lambs

ARS-ADP

Lambs acquired a marked resistance to small intestinal threadworms as a result of a light, relatively harmless infection. The previously exposed lambs withstood an attack of sufficient magnitude to injure seriously, or cause death of lambs of similar age and breed, previously unexposed to these pests. Intestinal threadworms are widespread among sheep and seriously injure the young animals. They normally enter the body of the lamb by boring through the intact skin, and cause hemorrhages of the lungs, diarrhea, anemia, reduced feed consumption and retarded growth. They are most common in lambs kept in pens. Since threadworms are not easily controlled by sanitation or treatment, immunization offers promise of a means of combatting these pests and circumventing losses caused by them.

Plans

This work is being continued.

Publications

Preliminary Report of Experimental Strongyloidiasis in Lambs.
J. H. Turner. Proc. Helminthol. Soc., 22:132-133. 1955.

6. Pelleted Feeds Help Overcome Injurious Effects of Parasitism in Lambs

ARS-ADP

Weanling lambs on pelleted feed (coop. New Mexico Agr. Expt. Sta.) resisted the injurious effects of the common stomach worm better than lambs of similar age and breed fed alfalfa hay. The pellets were prepared for fattening range lambs. The different feed constituents they contained were better balanced than those in alfalfa hay. Apparently the better balanced feed enabled the lambs eating it to overcome to a great extent the anemia and other devitalizing

effects of the parasites they harbored. This was evident from the fact that the lambs on the well-balanced feed gained 4 pounds more per animal, harbored fewer parasites, and showed milder symptoms than those on hay feed. In addition, they wasted less feed than the alfalfa-fed ones.

Plans

The investigations are being continued.

Publications

Effect of Two Rations, Differing Primarily in Protein, Carbohydrates, and Crude Fiber Content, on Experimental Haemonchosis in Lambs. K. C. Kates and G. I. Wilson. Jour. Parasitol., 41(6) Sect. 2:43. 1955.

7. Parasites Adversely Affect the Physiology of Lambs

ARS-ADP

Lambs experimentally infected (coop. North Dakota Agr. Expt. Sta.) with the more common intestinal parasites were unable to utilize fully the protein content of a good ration, maintain adequate hemoglobin, phosphorous and red-blood cell levels, essential for growth. Other changes included alterations in serum protein types, changes in water content of the droppings without a corresponding change in water consumption, and changes in sugar content of the blood. The findings may pave the way to a more rational approach than is now available to overcoming the devitalizing effects of parasitism and make possible material savings in costs of production.

Plan

This work is being continued.

8. Inferior Weight Gains Made by Lambs Grazed with Cattle

ARS-ADP

At Auburn, Alabama, lambs grazed with cattle made inferior weight gains because they acquired heavy loads of bovine strains of ruminant roundworms. Two types of parasites were involved, one occurring in the stomach and the other in the intestine. The work was undertaken because of a revival of interest in sheep production in the Southeast. The findings point up the danger of grazing sheep with cattle, or allowing sheep to graze on pastures previously used by cattle.

Plan

The work is being continued.

9. Phenothiazine-Resistant Strains of Sheep Parasites Discovered ARS-ADP

The occurrence of phenothiazine-resistant strains of internal parasites has been observed in a flock of sheep (coop. Kentucky Agr. Expt. Sta.) maintained continuously on a regimen of periodic drenching and free-choice administration of the drug for 10 years. From 2 to 4 times more phenothiazine is now required in low-level regimens to depress egg production by the parasites and inhibit development of the larvae than was formerly required. Moreover, in specific trials with the common stomach worm, from 4 to 8 times more drug was required to inhibit development of the larvae than is the case with normal strains. Although the findings require further confirmation, they point up the need for a thorough investigation of drug resistance among worm parasites of sheep.

Plans

Work is being continued.

10. Cause of Wasting Disease of Lambs Identified ARS-ADP

Outbreaks of a severe wasting disease of sheep in the West (coop. Montana Agr. Expt. Sta.) were traced to one of the intestinal roundworms, known as Nematodirus spathiger. This is the hardiest of the known intestinal worms affecting sheep. Observations showed that about 85 percent of the eggs and nearly half the larvae of these pests, which were exposed on the ground in the fall, were still alive the following spring. During the period of exposure, the egg and larvae were subjected to temperatures as low as -35°F., before the ground became covered with snow. During the summer months, however, many of the larvae were killed, presumably by sunlight, high temperatures and dryness.

Plans

The work is being continued to discover effective methods of controlling the parasites in order to prevent infection of lambs and circumvent losses of production that result from the infections.

11. Injurious Roundworm Parasite of Range Lambs in Nebraska Identified ARS-ADP

Evidence (coop. Nebraska Agr. Expt. Sta.) indicates that one of the numerous intestinal roundworms that infect sheep in the area may be more injurious to early lambs than any of the others. This parasite is known as Nematodirus spathiger. Infections of this parasite become intense in lambs before most other parasites are acquired by them. The marked ability of the larvae of Nematodirus to survive overwinter in far greater numbers than larvae of other roundworm parasites of sheep, appears to be responsible for the early, devastating infections encountered in lambs in the area.

Plans

Work aimed at development of methods for circumventing losses occasioned by this parasite is continuing.

12. Life History of Fringed Tapeworm Still Unsolved

ARS-ADP

Despite extensive trials (coop. New Mexico Agr. Expt. Sta.) the manner in which sheep become infected with the fringed tapeworm has not been solved. This tapeworm is widespread in western range sheep and certain wild ruminants. The young tapeworms invade the bile passages of the liver, damage the walls, and necessitate costly trimming at slaughter to remove the worms and associated lesions. This year large numbers of ants collected near pens used for housing infected sheep, springtails (small insects), and biting lice of sheep were fed to lambs with negative results. The springtails and lice had been experimentally fed the tapeworm eggs. Rabbits were fed egg capsules from the droppings of infected sheep, and their droppings were fed to lambs with negative results. Apparently the life cycle of the fringed tapeworm of sheep does not follow the same pattern as that of related tapeworms, which utilize certain insects as the intermediate host.

Plans

The work is being continued.

13. Poisons Produced by Coccidial Parasites

ARS-ADP

Progress is being made (coop. North Dakota Agr. Expt. Sta.) in the search for information on how parasites adversely affect the health of lambs and increase production costs. In work on coccidiosis, poisonous substances (toxins) were found in the gut of lambs that failed to survive a severe attack of this disease. The affected animals lost weight, and shortly before death became drowsy, partially paralyzed, and breathed with difficulty. Rabbits injected with the toxins exhibited the same symptoms and died within a few hours. Coccidiosis of varying degrees of severity occurs in lambs practically everywhere. The finding of toxins in severely affected animals may point the way to an understanding of the manner in which those parasites interfere with the health of lambs.

Plans

These investigations are being continued.

14. Inflammation of Intestines Caused by Coccidial Parasites ARS-ADP

Studies to determine the life history of coccidial parasites of sheep and the manner by which the parasites injure lambs were continued at Beltsville. A type of these parasites (Eimeria intracata) heretofore considered more or less harmless was used. Young lambs became sick within about 2 weeks following experimental infection, failed to eat, and lost weight. The intestine of animals so affected was inflamed, and swollen with fluid in the tissues. The parasites did not cause bleeding of the intestine as is known to be the case with certain other types. Lambs that survived a severe infection began shedding the transmitting stages (oocysts) of the parasites about 23 days after infection.

Plans

The work is being continued.

15. Strength of Lindane Dips Decreased by Successive Dippings ARS-ADP

In work at Albuquerque, New Mexico, lindane emulsion dips were found to lose their strength by successive passage of sheep through the fluid. After dipping 12 sheep in a vat containing 0.06 percent lindane, the concentration of active ingredient was reduced one-half; after dipping 48 sheep, the amount of active ingredient was reduced to almost zero. It is not known whether dips prepared with wettable powder are depleted to a significant degree, but the current practice of dipping in suspensions and emulsions, instead of the usual solutions, requires special study in the light of this finding.

Plans

Work on this and other aspects of the project is projected.

16. New Insecticide for Lice and Ticks ARS-ADP

Investigations at Albuquerque, New Mexico, showed that sheep ticks and lice can be readily destroyed by proper applications of Malathion, an organic phosphate of low toxicity to mammals when used in concentrations required to destroy external parasites. This chemical may warrant a more prominent place among the reliable treatments.

Plans

Work is being continued to evaluate the usefulness of Malathion in controlling these pests.

17. Rabbits a New Host of Common Scab Mite of Sheep

ARS-ADP

Investigations at Albuquerque, New Mexico, showed that the mites that cause common scab in sheep, Psoroptes equi ovis, can be successfully established on clean laboratory rabbits, producing extensive lesions. This finding, following upon the evidence of ready cross-transmission of scab mites between cattle and sheep, raises significant questions about possible reservoir hosts of these parasites. Use of the rabbit, however, provides an economic means of more intensive study of the disease, including the natural mode of transmission, methods of treatment, and control measures.

Plans

Work is being continued.

G. RANGE MANAGEMENT AND IMPROVEMENT

1. Grazing Management of Native Range

FS-RMR

Grazing management research on forest and related ranges in the West and South aims to determine optimum intensities, seasons, and systems of grazing and livestock handling practices for efficient use and high sustained production of the forage resource.

Alpine and subalpine sheep ranges are as productive as most lower elevation ranges in Colorado and adjoining States. These ranges were generally found to have good ground cover but variable productivity. Annual production of herbage palatable to sheep was as high as 1,146 pounds per acre on the best "meadow sites" and up to 581 pounds per acre on some well-drained slopes. On lower-elevation ranges in the pine zone of Colorado, production of palatable grass and sedge herbage has averaged between 500 and 700 pounds per acre in grassland parks, and between 200 and 300 pounds in open timber.

Contrary to the prevailing condition on the 2 million acres of aspen-type ranges in the Intermountain region, the forage production potential has been found to be higher in openings than beneath the aspen canopy. As a rule, existing vegetation of the numerous openings is sparser and shorter and has a smaller proportion of desirable forage species than vegetation beneath the aspen. By planting desirable native species on the two kinds of sites in Utah, it was shown that the currently prevailing situation results from the tendency of cattle, and sheep to a lesser extent, to graze more heavily in openings than within aspen stands. These results provide an additional basis for judging range condition in the aspen type; for good condition, forage production in openings should be at least as good as under the trees.

Plans

Research to develop improved grazing management practices on forest and related ranges of the West should be expanded. There are extensive areas for which suitable practices have not yet been developed for managing livestock grazing to assure maximum production of forage and livestock consistent with maintenance of good watershed cover and other values of these lands. Current effort on sheep range is particularly meager. (See Proposals for Committee Consideration).

Publications

Comparisons of Protected and Grazed Mountain Rangelands in Southwestern Montana. Anthony B. Evanko and R. A. Peterson. Ecology 36(1): 71-82. 1955.

Grazing Season Determined by Forage Maturity. Richard S. Driscoll. Oreg. Cattleman 4(2):6, 13-15, 1955.

Plant Vigor as a Criterion of Range Condition. L. R. Short and E. J. Woolfolk. Jour. Range Mangt. 9(2): 66-69. 1956

Grazing Capacity of Wiregrass-Pine Ranges of Georgia. L. K. Halls, O. M. Hale, and B. L. Southwell. Georgia Agr. Expt. Sta. Tech. Bul. N. S. 2. 38 pp. 1956.

2. Grazing Management of Seeded Rangelands

FS-RMR

Determination of optimum intensities and systems of grazing for seeded forest and related ranges, and development of efficient procedures for using these ranges in connection with native range are objectives of this research.

A 10-year sheep grazing study near Ephraim, Utah, has provided valuable criteria for efficient management of crested wheatgrass as spring-fall sheep range. Grazing for a 6-week period in the spring, and about 2 weeks in the fall, with average utilization of 71 percent of the herbage, during the first 7 years resulted in greater forage yields and sheep gains per acre than heavier grazing (88 percent), and was essentially equal to a lighter degree of use (59 percent) in these respects. Under the heaviest rate of grazing during the first 7 years the centers of crested wheatgrass clumps died, the remaining clumps were smaller and 5 times as much low-value Russian-thistle came in as under the two lighter intensities. After 10 years, crested wheatgrass has been virtually eliminated and replaced by bulbous bluegrass and weeds on the ranges receiving the heaviest grazing use. Under the lighter grazing rates a gradual decadence is associated with increasing age of the stands and there is some indication the new plants of crested wheatgrass may be unable to become established in competition with the bulbous bluegrass.

In a study of grazing management of seeded grasses at the U. S. Sheep Expt. Sta. (coop. APH and Idaho Agr. Expt. Sta.) intermediate, pubescent, Fairway and Standrad Crested and bluestem wheatgrass produced more forage than Russian wildrye and Siberian, tall, thickspike and bluebunch wheatgrass. The first four species were more palatable to sheep for spring grazing than the last six.

Plans

Research on management of seeded ranges will be continued.

3. Control of Undesirable Range Plants with Fire and Grazing Management

FS-RMR

Determining the place of fire and grazing management in controlling undesirable plants of forest and related ranges, the conditions responsible for increases of such plants, and the kind of management required to prevent re-invasion following control by any method are objectives of research in this project.

Early results at Desert Experimental Range in Utah indicate that spread of halogeton can be suppressed where desert-shrub winter ranges used by sheep in the winter are maintained in good condition. Halogeton planted on ranges where about half of the key forage species had been utilized each year since 1935 spread only 8 feet from original plantings between 1954 and 1955. In contrast, where utilization had been two-thirds or more, the spread was 40 feet.

On semidesert grass-shrub ranges in southern Arizona, burroweed was almost completely killed by prescribed burning twice, three years apart. Prescribed burning was not effective in controlling cholla cactus species because surviving joints broke off, fell to the ground and started new plants. On chaparral mountain range in central Arizona pointleaf manzanita was killed by a single burn; desert ceanothus, hollyleaf buckthorn, and skunkbush were largely killed by burning 2 years in succession; but control of shrub live-oak was infective. Prescribed burning for juniper control in the Southwest appears to be most feasible where stands are dense and where alligator juniper, which sprouts profusely, is not present. More detailed prescription of the use of fire and conditions under which juniper burning is practical or feasible is needed before large-scale work can be undertaken. Tests in Arizona (coop. Arizona Agr. Expt. Sta. and Bureau of Indian Affairs) have shown the juniper control may treble forage production, but natural recovery to maximum production may require 10 years or longer.

Eradication of sagebrush by burning resulted in a greater increase in range forage available to sheep than control by railing or spraying in the third year of comparisons at the U. S. Sheep Expt. Sta. (coop. APH and Idaho Agr. Expt. Sta.). On sprayed and railed areas,

considerable forage was unavailable to sheep because of standing shrubs. Burning retarded grass recovery by initial reduction in vigor, but markedly favored increases of perennial forbs that are valuable on spring sheep range as compared to other methods of control.

The importance of considering all plants on the range in planning improvement by spraying with 2,4-D for sagebrush control is emphasized by studies conducted near the U. S. Sheep Expt. Sta. (coop. APH). Several desirable forbs and shrubs of particular importance for sheep and game grazing were found to be killed along with sagebrush. Similar results have been found in the Bighorn Mountains in Wyoming where spraying with 2,4-D caused a 2/3 reduction in forb production.

Plans

This research will be continued.

Publications

Juniper Control as a Range-Improvement Practice in Central Arizona. Joseph F. Arnold. Ranch Day, Jornada Experimental Range, Las Cruces, New Mexico. 1955-7-10a. 1955. (processed)

The Effects of Prescribed Burning a Grass Shrub Range on Burroweed, Cholla, Pricklypear, Mesquite, and Other Shrubs. John W. Bohning. Ranch Day, Jornada Experimental Range, Las Cruces, New Mexico 1955:11-13. 1955. (Processed)

Juniper Control Increases Forage Production on the Fort Apache Indian Reservation. Joseph F. Arnold and W. L. Schroeder. Rocky Mt. Forest and Range Expt. Sta. Station Paper No. 18, 35 pp. 1955. (Processed)

4. Livestock-Game Range Use Relations

FS-RMR

Cooperative studies in a few areas of the West are providing some of the information urgently needed to resolve conflicting interests and successfully integrate management of big game with livestock, and to rehabilitate game ranges.

Research in Utah (coop. Utah Agr. Expt. Sta. and U. S. Fish and Wildlife Service), shows that deer and sheep compete more for forage than cattle and deer, both in areas grazed and choice of plants. On Monroe Mountain about 80 percent of the area was grazed intensively by both deer and sheep. On summer ranges 6 out of the 10 species most prominent in either sheep or deer diets were also prominent in both, the chief difference being much greater use of grass by sheep. Spring diets on depleted foothill range were very similar, consisting chiefly of young grass and browse. In late fall, browse species grazed by sheep were the same as those preferred

by deer in winter. On deer-cattle ranges at Oak Creek, heavy grazing by both deer and cattle occurred on 1/5 of the summer range and 1/3 of the winter range. In summer, deer fed mainly on forbs and browse, while cattle relied mainly on grass if available. Winter food of deer was mainly browse. Most of their choice browse species were used somewhat by cattle in spring and fall, but deer used very little of the cattle's preferred grasses except for a short period in early spring.

Successful seeding of bitterbrush, one of the most valuable western browse plants for big game as well as for sheep, is exacting. Appropriate depth and time of planting have been found to vary with annual precipitation, soils, and hazards of frost-heaving. In northeastern California, (coop. California Agr. Expt. Sta. and U. S. Fish and Wildlife Service) optimum planting depth varied from about 3/4-inch where precipitation and soil fertility were favorable to 1-1/3-inches where precipitation was lower and soils poorer; optimum depths were slightly greater for spring than fall seedings. In southwestern Idaho (coop. Idaho Agr. Expt. Sta.) increasing the depth of planting delayed emergence in the spring and helped avoid losses from frost-heaving, but also decreased emergence of seedlings. Planting 4 to 8 seeds per spot, at a depth of 1-1/4 inches, gave satisfactory delay and emergence. Improvement of bitterbrush seed stock through selection, and development of strains that sprout after burning seems promising. Studies, where sprouting is fairly common, showed this character to be influenced both by genetic and environmental factors. Investigations of the inheritance and morphology of sprouting have been initiated (coop. California Agr. Expt. Sta.).

Plans

Research in this important field will be continued but work should be intensified and expanded (See Proposals for Committee Consideration).

Publications

Deer and Livestock Relations in Utah. Odell Julander. Utah Acad. Sci., Arts and Letters Proc. 32:202-203. 1955.

Artificial Revegetation Studies on Depleted Big-Game Winter Ranges in Idaho. Joseph V. Basile and Ralph C. Holmgren. Job Completion Reports, Idaho Fish and Game Dept., 23 pp. 1955 (Processed).

Sprouting of Bitterbrush (*Purshia tridentata*) Following Burning or Top Removal. James P. Blaisdell and Walter F. Mueggler. Ecology 37(2): 365-370. 1956.

Competition Between Annuals and Young Bitterbrush (*Purshia tridentata*) in Idaho. Ralph C. Holmgren. Ecology 37(2):370-377. 1956.

Quick-Testing Bitterbrush Seed Viability. Eamor C. Nord. Jour. Range Mangt. 9(1):193-194. 1956.

5. Range Plant Investigations

FS-RMR

Studies of distribution, life history, ecological and physiological requirements, productivity, forage value and other aspects of native and introduced plants of forest and related ranges are a basic and integral part of range management research.

Studies of reproduction and establishment characteristics of velvet mesquite in Arizona explain the pernicious invasion and spread of this undesirable shrub in semidesert grasslands. It produces an abundance of seed which under certain conditions may remain viable 50 years, but if covered by soil they germinate under a wide range of temperature and moisture conditions. Seeds are most commonly disseminated and covered by livestock, rodents and runoff water. Seedlings develop rapidly and have a marked resistance to drought. A good grass cover greatly reduces establishment and survival of mesquite seedlings but does not entirely prevent establishment of seed planted by rodents. Good grazing practices will retard mesquite spread into uninfested grassland, but once introduced plants reach seed-bearing size, the population will increase--and grasses decrease--until artificial control measures are applied. Burning late in the spring kills small mesquite seedlings, but larger plants usually resprout.

On Bighorn mountain ranges in Wyoming, herbage growth of Idaho fescue was found to develop at a consistent rate at any one elevation, but to begin successively later as elevation increased from 7000 to 9500 feet. After vigorous growth started, plants attained maximum herbage weight in 70 to 75 days; then weight diminished 1 percent per day for 2 weeks, presumably a result of food transfer to storage organs. Besides being the dominant grass on these ranges, Idaho fescue has been found to be highest in productivity, protein content, and palatability. In descending, order of protein content and preference to cattle, important associated grasses are: big bluegrass, pumpelly brôme, slender wheatgrass and subalpine needlegrass.

Plans

Research of this nature will be continued.

Publications

Reproduction and Establishment of Velvet Mesquite on Semidesert Grassland. George E. Glendening and Harold H. Paulsen, Jr. USDA Tech. Bul. 1127, October 1955.

6. Rodent Influences on Rangelands

FS-RMR

Studies at a few locations in the West seek to determine the nature and extent of rodent influences on forage production, ecological trends, and soil and watershed conditions on forest and related ranges,

and to develop criteria for determining when rodent control measures are justified in practical management.

Results on seeded mountain rangelands are showing that pocket gophers cause serious damage. In northern Utah (coop. Utah Agr. Expt. Sta. and U. S. Fish and Wildlife Service) stands of seeded grasses on the brown soil phase of a soil type yielded 78 percent less forage over a 3-year period on gopher-infested areas than where gophers were controlled. On the grey soil phase of the same soil type, which was less heavily infested with gophers, the reduction in yield was 42 percent. In the mountains of eastern Oregon, pocket gophers destroyed 30 percent of the seeded stands of 3 wheatgrasses, and 84 percent of the stand of tall outgrass by the fifth growing season. Gophers were having no further influence on old plants of 9-year-old stands of crested wheatgrass in Oregon, but they were preventing establishment of young plants between 24" drill rows and any thickening of thin stands. A comprehensive study of pocket gopher-rangeland relations and practical methods of control was started in Colorado in 1955 (coop. U. S. Fish and Wildlife Service, Colorado Agr. Expt. Sta. and Colorado Cattlemen's Association).

Plans

This research will be continued.

Publications

Relations of the Dalles Pocket Gopher to Establishment and Maintenance of Range Grass Plantings. George A. Garrison and A. W. Moore. Jour. Range Mangt. 9(4):181-184. 1956.

H. ECONOMICS OF PRODUCTION

The following publications were issued during the year:

Southwestern Sheep Ranches--Organization, Costs and Returns, 1940-54. James R. Gray. New Mexico Agr. Expt. Sta. Research Report 7.

Labor Structure and Labor Problems--Utah Sheep Ranches, 1952-1953. William A. Dehart and William H. Metzler. Utah Agr. Expt. Sta. Bulletin 378.

Farm Flocks of Sheep on Irrigated Farms in Montana. D. C. Myrick. Montana Agr. Expt. Sta. Bulletin 512.

I. SUPPLEMENTAL

1. Biting Gnats

ARS-ENT

Research has been initiated on a small biting gnat, Culicoides variipennis, which is a likely vector of bluetongue disease of sheep. In order to obtain information on its life cycle and to have a source of supply of the various stages for insecticide and disease transmission experiments, methods are being developed for rearing the insect in the laboratory. A colony has now been maintained for several generations. The larvae are reared in small pans containing fresh cow manure mixed with soil and water. At 75° F. the life cycle is completed in about 30 days. The adult gnats are caged over a rabbit's ear and readily take blood. Several feedings are necessary before eggs are laid.

Plans

Continue studies on the biology of these insects and develop effective and safe insecticides to control them.

Publications

Mosquitoes and Gnats Affecting Livestock. A. W. Lindquist and W. C. McDuffie. USDA Yearbook of Agriculture 1956.

Insects as Livestock Pests. A. W. Lindquist. Proc. 42nd Ann. Meeting Chem. Spec. Mfrs. Assn., 1955, pp. 145-148.

2. Screw-Worm Research

ARS-ENT

The successful eradication of the screw-worm from the 170-square-mile island of Curacao by the systematic release of adult male flies sterilized by atomic irradiation has stimulated interest in the use of this method for the possible elimination of the pest in the southeast. The State of Florida provided some funds to assist in the research to determine the feasibility of this method of control on the mainland. Good progress has been made in devising facilities, techniques, equipment, a lower cost breeding medium, and procedures for rearing and sterilizing millions of flies needed in an eradication program. In a recent trial run, one million flies per week were produced and the procedures used can be projected to a plant fifty times larger. Progress has been made in developing an artificial attractant for the female screw-worm fly, but much more research is needed before a substance is developed which will supplant the use of wounded goats for evaluating the effects of released sterilized flies against natural populations.

Plans

Continue research on development of economical rearing procedures, determinations of practical airplane swath widths for release of flies, intervals of releases of flies, and attractants.

Publication

Screw-Worms and Fleece Worms Attacking Livestock. G. W. Eddy and R. C. Bushland. USDA Yearbook of Agriculture 1956.

3. Lice and Ticks

ARS-ENT
&ADP

Research during the past year resulted in the discovery of several promising insecticides for the control of lice on sheep and goats. In large scale spray tests on freshly sheared goats, 0.01 percent Diazinon emulsion and 0.1 percent malathion suspension eradicated heavy infestations of lice and prevented reinfestation for several months. No evidence of toxicity to the animals was noted following treatment, indicating that both materials may be used safely at these concentrations.

Plans

Continue research on the development of more effective insecticides and methods of application for the control of sheep and goat lice.

Publications

Lice and Keds of Sheep and Goats. H. O. Peterson and R. C. Bushland. USDA Yearbook of Agriculture 1956.

4. Increasing Productivity of Mountain Meadows

ARS-SWC

Combining best irrigation, crop management, and fertility practices on mountain meadows has greatly increased their productivity. These improved practices, including shifts from semi-continuous to intermittent irrigation, one-cut to two-cut harvesting, and the use of commercial fertilizers, particularly nitrogen, have caused marked changes in the species composition of mountain meadows. Grasses, particularly smooth brome, have increased, clovers have essentially been eliminated, and the dandelion-weed complex has decreased. Earlier harvesting of meadows, either as hay or pasture, has been shown to be profitable because of the higher protein content of the forage. Beef cattle used to evaluate animal productivity of the meadows showed a beef production of about 540 pounds per acre with improved practice as compared to about 180 pounds per acre with normal rancher practice. The hay and pasture producing potential of mountain meadow lands is yet to be realized, but the present research effort is pointing the way.

5. Quality of Lamb Meat Affected by Breeding, Feeding and Management

ARS-APH

Additional evidence has been obtained that lamb carcasses and their meat characteristics continue to show improvement through breeding. These results are based on five year's data on lambs from four pure breeds, three two-breed crosses, four three-breed crosses, four four-breed crosses and some triple breed intercrosses. All the meat came from ram lambs nursed on their mothers while on pasture. The lambs were slaughtered when they reached a final weight of approximately 75 pounds. Palatability data from lamb leg samples, representing the various breeds and crosses indicated little difference in the quality factors of intensity and desirability of flavor of fat and lean. The purebred Southdowns were the most tender, but this was lost by crossing. Likewise all first cross lambs had less tender roasts than the parent purebred representatives.

Plans

Continue at present level in breeding studies. Expand research studies on those important quality factors of yield, composition, grade, tenderness and palatability as affected by feeding, management, age and sex.

PROPOSALS FOR
COMMITTEE CONSIDERATION

I. PRODUCTION

1. Comprehensive and Coordinated Investigations on Production of Sheep and Utilization of Meat and Wool

Initiate and/or expand a program of research to establish the complex relationships and interactions between genetic and environmental factors such as breeds of sheep, breeding systems, flock management practices, types of range, feeding regimens or levels of nutrition, climatic conditions, geographical locations and other production variables, and the quality, quantity and resulting economic value of the meat, wool, skins, and byproducts.

The work should be initiated at various geographic locations on genetically stabilized groups of sheep. The effects of genetic, environmental and nutritional factors on important traits of lamb and wool production should be studied. Initial emphasis should be given to production traits of body and fleece and to a detailed investigation of qualities of wools from groups of sheep maintained at various geographical locations. At each location part of the group should be on feed typical of the area, with controls at all locations fed a standard normal diet. Production traits studied should include traits such as: body weight, conformation, fleece weight, staple and fiber length and crimp, diameter, handle, and yield of clean wool, card sliver, top and noils. The wool qualities to be investigated in detail should include: color, susceptibility to yellowing tensile strength, and other mechanical properties, and chemical reactivity to bleaches, dye-stuffs and other processing chemicals.

2. Sheep Breeding Investigations

Expand work on breeding methods to improve the efficiency of farm and range sheep. Special attention should be given in the Southern States to the breeding of sheep suited to the early production of lambs on pasture, and in other farm areas to sheep developed for maximum production of lambs and wool on a minimum of supplemental feeds. New work should be undertaken on evaluation of methods of line combination and of the combinations of the numerous lines of range sheep. Work on means of increasing improvement of sheep by selection and also for prolificacy should be expanded. Such undertakings in sheep breeding research are needed for improvement in the quality and quantity of lamb and wool production.

3. Ruminant Bloat

Basic investigations should be expanded on this important problem which constitutes a serious deterrent to greater utilization of high productive legume pastures and to the use of the better grades of alfalfa hay in some areas. Particular emphasis should be placed on intensive studies to determine the physiological, bacteriological, and pathological characteristics of animals bloating under natural conditions, so that field bloat can be correlated with studies on the production of experimental bloat. Studies on the physiology of eructation of sheep should be completed and studies on the bacteriological aspects of bloating in sheep should be initiated. Work should be expanded on the determination of the chemical, pharmacological and physiological characteristics of legumes and hays that cause bloat, and detailed studies should be initiated to determine the changes in all known and suspected properties of bloating feeds as related to species and varieties, age of plant, diurnal and seasonal growth, climatic factors and plant nutrition.

4. Efficiency of Feed Utilization by Sheep

Research should be initiated and/or expanded on four major problems with feed utilization by sheep. (1) New or improved methods for estimating the productive value of coarse, fibrous feeds for sheep must be developed so that feeding and supplementation progress can be built around the use of cheaper feeds for maintenance, growth and reproduction of breeding animals. Present systems of evaluating feeds, based largely on digestion studies, overestimate the energy value of poorer quality roughages as compared with high quality roughages or concentrates. (2) Additional information is needed on the interrelationships between a number of factors such as physical balance of the diet, chemical composition of the feeds, salivation, pH of ruminal contents, microbial activity and their relationship to efficiency of feed utilization and the development of acute and sub-acute digestive disorders by fattening lambs. (3) Definite information is needed on the energy requirements for maintenance, for various activities such as grazing or walking, and for growth, fattening, pregnancy and lactation. Such work will greatly aid in the development of new and better methods, for evaluation of the productive energy content of harvested feeds, pasture and range forages, which are directly applicable to sheep. (4) Expansion is needed in work to measure the efficiency of feed utilization of breeds, strains and individual sheep to determine the extent to which efficiency of feed utilization can be improved through breeding.

5. Supplementary Feeding of Range Sheep

Expand studies to develop improved supplementary feeding practices for both average and emergency range conditions in the Western and Southern Great Plains sections. This work should be aimed at the maintenance of breeding animals, for wool production and for the

growth and development of lambs. Existing information on the kinds and amount of supplementary feeds needed for various classes of sheep is entirely inadequate. The amounts and kinds of supplement needed will undoubtedly vary from area to area according to the type and amount of range forage available so that observations will be needed from a number of representative locations and under emergency conditions due to extended drought and unusual snowfall in the important range areas. Considerable additional work will have to be devoted to the development of special techniques for the evaluation of the feed value of range forage and for measuring the effects of supplements.

6. Bacteriology and Metabolism in the Rumen of Sheep

Bacteriological studies with sheep should be expanded to (1) determine the factors that support a beneficial rumen microflora and (2) determine the factors that support an abnormal or harmful bacterial population in the rumen. The ability of sheep and other ruminants to utilize roughage depends on the activity of microorganisms in the rumen. Preliminary findings that certain factors are necessary for test tube cellulose digestion should be followed up by additional bacteriological studies and then by practical feeding tests. The effect of a number of factors (trace minerals, grass-juice factors, fatty acids, ill-defined or "unknown" factors present in certain feeds) as they are concerned with the digestion and utilization of roughage should be explored by extensive experimentation with sheep. Certain metabolic activities in the rumen, however, are not beneficial but can lead to enterotoxemia and other digestive disorders and may contribute to bloat. The effects of factors, such as diet composition and level of feeding, on the development of an abnormal rumen flora should be determined.

7. In Vitro Rumen Studies Using Radioactive Tracers

Further research should be carried out with the "artificial rumen" technique utilizing radioisotopes as tracers to evaluate the effects of various dietary factors upon microbial synthesis. A major portion of the dietary nutrients which are consumed by sheep are first assimilated by rumen microorganisms before they are made available to the animal. As a result of microbial synthesis in the rumen, high quality protein and an ample supply of vitamins may be made available to sheep that are fed rations deficient in these respects. The use of labeled sulfur compounds as tracers will provide an extremely sensitive measure of the extent to which a labeled nutrient is assimilated by the microbiota and will have a further advantage in that it will be possible to determine the chemical form in which radioisotope occurs and thus trace the metabolic pathway of the labeled material.

8. Methods of Management for Sheep Production

Expand investigations to develop more efficient methods of management for sheep production both on farms and ranches. Sheep producers have sometimes been criticized for failing to increase the efficiency of lamb and wool production in recent years. Inter-relationships of breed, climatic factors, nutrition, shelter, protection from predatory animals and methods of handling need to be determined in regard to their various effects on efficiency of lamb and wool production. Comparisons of fenced versus unfenced or herded ranges need to be made in areas where sheep herding is now practiced. Comparison of sheep grazing alone and with other classes of livestock under varying conditions needs further study.

9. Tissue Culture as a Tool for Fiber Growth Studies

Initiate research in tissue culture for the purpose of imitating the growth of skin and wool under conditions where succeeding stages of development can be directly observed. Tissue culture as a tool would help to establish the basic principles concerned in fiber development and growth. It is also by this means that the exact mode of pigment cell appearance and development could be followed. Armed with this knowledge, the problem of eliminating black fibers from wool of sheep could then be efficiently attacked. Results of this fundamental research on wool could have wide application for increasing the efficiency of wool production and for improving wool quality.

10. Effect of Nutrition of Pregnant Ewes on the Development of the Primary and Secondary Fiber Follicles in the Unborn Lamb

Research should be initiated to determine the effect of protein and other dietary factors in the ration of the pregnant ewe on the initiation of primary and secondary fiber follicles in the fetal lamb and thus on the ultimate wool production of the offspring. It is known that nutrition can have a direct effect on the yield and quality of wool from adult sheep, however, very little is known about the influence of nutrition of pregnant ewes on the ultimate wool production of their offspring.

11. Variability of Fiber Length in Range Fleeces and Resulting Top

Initiate research to determine variability of fiber length in individual fleeces, the anatomical and physiological bases for such variability, and the extent to which variability in fiber length of wool tops may be due to variability within and between fleeces, to weak fibers or breaks in the wool, and to damage in processing. The results of this research will provide a more sound basis for improvement of wool.

12. The Importance of Crimp in Wool Production

Initiate research to measure staple and fiber crimp, to determine the effect of measurable environmental factors on crimp, to estimate its heritability, to determine its relation to other important wool production traits, including factors involved in producing high quality top and yarn. This research will help determine the importance of crimp in breeding for more efficient production of high quality wool.

13. Influence of Production Factors on the Quality and Yield of Lamb Meat

Expand studies on the influence of breeding, age, sex, feeding, market finish, environment and other production factors on the quality and yield of lamb meat. Such studies on yields and composition of edible meat in carcasses and cuts, and of organoleptic characteristics as influenced by such production factors are urgently needed to assist in the development of better quality lamb meat and in creating a greater demand on the part of the consumer.

14. Poisonous Plants

Expand studies on poisonous plants to determine the role of a number of plants as the direct and indirect cause of sheep losses. There are a number of such plants in the Western States and little has been done on poisonous plants for sheep in Eastern and Southern States. The effects of herbicides and industrial air pollution on making some plants poisonous need investigation.

15. Variability of Fiber Length in Grease Wool and Resulting Top

Initiate research to determine variability of fiber length in individual fleeces, the anatomical and physiological bases for such variability, and the extent to which variability in fiber length of wool tops may be due to variability within and between fleeces, or to weak fibers or breaks in the wool. Expand work to determine the changes which take place in staple and fiber length in scoured wool, carded, and wool top to facilitate the development of length specifications for the different grades. The results of this research will provide a more sound basis for improvement of wool and in determining the value and utility of wool.

16. Internal Parasites

Expand and where necessary initiate research to evaluate the impact of parasitism on the economy of lamb and wool production, and to develop methods for preventing or minimizing these losses by control and eradication. Parasites constitute an important stress factor that endangers health and therefore increases costs of production.

It has been estimated that about 10 percent of production costs each year goes to maintaining parasite infestations in flocks.

In some areas the cost of parasitism is even greater. Attempts to rejuvenate and maintain sheep production in parts of the South are being thwarted by parasites. There are several recent instances where attempts to initiate sheep production have been made and abandoned because of the ravages of parasitism in the flocks. There are instances, moreover, where tremendous financial losses have been sustained by feeders in the Midwest because of parasitism in feedlot lambs brought in from the West pyramided under feed lot conditions and resulted in widespread death losses. Parasites thrive best where moisture is present, such as on heavily-stocked pastures, on which there is good natural rainfall or which are irrigated. Pastures are constantly being improved for irrigation and stocked rather heavily, which increases the hazard of parasitism almost in direct proportion to the degree of stocking.

Unless impeded, the toll which parasites extract from the income of producers will continue and even increase each year. In order to meet the menace of parasitism it is necessary to expand the work to ascertain basic facts regarding such factors as: (a) The impairment by parasites of the normal physiology and growth rate of affected sheep, and on the quality of carcasses and wool; (b) evaluating the role of parasites on the economy of sheep production on irrigated pastures; and (c) development of effective preventive and curative treatments and practical methods of administering them.

17. Range Grazing Practices

Expand research to develop grazing practices for sheep on forest and related rangelands of the West, which will improve and maintain forage and livestock production at the maximum level consistent with watershed protection and other values. Additional research in range plant ecology and physiology is needed to provide an understanding of basic management requirements for favoring desirable range plants and controlling undesirable ones. Critical and practical criteria for judging present and potential productivity of these ranges are needed. On extensive areas present range productivity is far below its potential and the needs of the livestock industry. Increased research is needed to define specific requirements and grazing practices for many important range types of value for sheep grazing.

18. Game Range Management and Improvement

Expand research on forest and related rangelands to develop basic principles and practices for intelligently integrating game and sheep grazing, and for restoring and maintaining high productivity on depleted game range. To be determined for important range types are: (1) Compatability and competition between game, sheep and cattle;

(2) requirements of browse and other game forage plants fundamental to practical management; (3) proper stocking and utilization of game range, and critical and practical criteria for recognizing proper use and evaluating present productivity in relation to the potential; (4) methods for restoring production of game forage through seeding or other practices; (5) effects of big game on sedimentation and other watershed factors. Such information is critically needed for western ranges grazed by big game or game and livestock. Big game numbers have more than doubled during the past 20 years in many areas and present grazing capacity of deteriorated ranges falls far short of meeting the demand. Interest by State game and fish departments is sufficient to insure strong cooperation on needed studies.

19. Insect Pests of Sheep

Initiate or intensify basic and applied research on the control of insect pests and/or vectors of diseases of sheep. Very little is known about a group of small biting gnats (Culicoides) which are probably vectors of blue-tongue disease of sheep. The relationship of these and other insects to the transmission of blue-tongue and other diseases have not been determined. Research is needed to develop more effective insecticides (spray and systemic) to control pests of sheep such as lice, ticks, biting flies, screw-worm, fleece worm, and bots.

20. Effect of Mineral Interrelationships in Animal Nutrition

Expand studies on mineral interrelationships in animal nutrition. The ways in which the level of any one essential element present in the feed effect the functioning of other elements are not well established. For example in the course of studies of the effect of high levels of molybdenum on the copper status of the animal, the observation was made that a sulfur amino acid would alleviate the growth retardation produced in laboratory animals. This and related observations point to the need for studies such as determination of the effect of varying levels of molybdenum and copper to determine how these elements are interrelated in the metabolism of animals. Such information is essential for an understanding of nutrient imbalancing of rations by mineral elements.

21. Soil and Water Management Practices for Improvement of Rangeland

To initiate research on soil and water management and conservation practices adapted to the vast expanse of rangeland in the Western United States. This research should be geared to the determination of an efficient level of use in relation to erosion control, run-off and water intake; and of fertility requirements in relation to soil type, moisture availability and plant species for various range areas. It should also include a study of practices related to stand maintenance, seedbed preparation and renovation. The possibility of reducing run-off through methods such as pitting, furrowing or terracing should be determined.

II. UTILIZATION AND CONSUMER USE RESEARCH

A. CONSUMER-USE

1. Fabric Properties and Serviceability

ARS-CH

A compilation of research data on fabric quality has brought together results of investigations of properties and serviceability of 1354 different household and clothing fabrics classified under 26 categories. Included are wool and part wool fabrics of flannel, serge, gabardine, blanketing, and upholstery. The data, selected from studies made by the Department, by agricultural experiment stations, and by colleges and universities engaged in textile research, furnish a basis for recommending acceptable qualities for certain fabrics, and point out gaps where further research is needed.

Facts on present-day fibers, fabric constructions, and finishes have been prepared for publication to provide a basis for consumer education on clothing fabrics.

2. Usefulness of Experimental Suitings in Work Trousers

ARS-CH

Until laboratory tests for durability give data that are consistent with results of actual wear, it is not possible to predict serviceability of clothing through laboratory tests alone. Serge fabrics made into trousers, worn until the wearers considered them unsuitable for work, still retained more than half their original bursting strength. Plans are being made to study the data statistically in order to establish a relationship between visual judgment of garment condition at different stages of wear and the residual bursting strength of the worn fabric. As the hours of wear increased, worn sections of the trousers, upon microscopic study, revealed an increase in the total number of fiber ends per inch of yarn and the ratio of damaged to undamaged ends. The possibility is being explored of using this measure as a basis of comparison of laboratory and actual wear abrasion.

In studies to determine the usefulness of medium and coarse domestic wools for utility clothing, six experimental whipcord suitings were used, namely: two all-wool fabrics, one made from 64's and the other from 56-58's; two made from wool-nylon blends, 56 to 58's and 48-50's and two from wool-rayon blends, 56 to 58's and 48-50's. An equal number of trousers were made from each suiting. 48-50's wool, seldom used for clothing, when blended with rayon or nylon, produced fabrics acceptable to truck drivers in the D. C. area who are wearing the trousers as a part of a serviceability test. Serviceability findings to date indicate the possibility of using the coarse wool in work clothing. During four winter seasons, the trousers have now reached 60 weeks of actual wear by the truck drivers, and have had 60 dry-cleanings.

Plans

These studies will be continued until none of the trousers are acceptable for wear.

3. Disinfectants for Wool Fabrics

ARS-CH

Studies are continuing of the efficacy of using quaternary nitrogen compounds to impart bacteriostatic properties to fabrics. Directions commonly furnished for use of the agents on infants' garments, bedding, and similar articles, specify a unit weight of the product to a given weight of fabric with no indication of the volume of water to use. The amounts of quaternary removed from the germicide solution by a standard sample of wool fabric varied with the concentration and the volume of germicide solution used. However, on subculturing the germicide-treated wool in the presence of Proteus mirabilis, the quaternary only partially inhibited the test organism, regardless of the ratios of the concentrations and volumes used. This failure of the quaternary to render the wool completely bacteriostatic may be explained by the finding that only a very small amount (5 to 15 percent) of the quaternary desorbed after application to the fabric. The lack of bacteriostatic effect on wool is in contrast to the previously reported efficacy of quaternaries as disinfectants for wool. The results have been published.

Plans

Research with germicides will continue with emphasis on the use of fluorides.

Publications

The Effect of Quaternary Treatment Under Varied Ratios of Weight-Volume-Concentration on the Bacteriostatic Property of Fabrics.

M. T. Goldsmith, M. A. Latlief, J. L. Friedl, and L. S. Stuart. Appl. Microbiol. 4 (2): 91-94. March 1956.

Properties and Serviceability of Selected Household and Clothing Fabrics. Bibliography and Review of Research Findings 1928-1951. H. M. Fletcher and S. H. Roberts. AIB 147. May 1956.

B. NEW AND IMPROVED WOOL PRODUCTS

1. Modification of Wool to Retard Yellowing

ARS-WU

The wool fiber has certain recognized deficiencies, notable among which is the tendency towards off-coloring, particularly yellowing. The problem is important because of the continuing trend to lighter shade fabrics which puts a premium on whiter wools. This is one reason why the whiter foreign wools have been preferred. Yellowing

of wool can occur from several causes. Long storage of raw wool, especially under conditions of elevated temperature and heat, promotes yellowing. Another kind of yellowing occurs in clean wool and is noticed especially in wools exposed to light for extended periods. Little is known regarding the mechanism of these yellowing reactions and what steps need to be taken for their control.

(a) Yellowing Accelerated by Impurities in Grease Wool - Previous results described the discoloration of wools by heat in the presence of moisture and the promotion of such discoloration by a trace constituent in wool suint, identified as urocanic acid, a known component of human perspiration. This acid has now been isolated from suint as a crystalline, slight/soluble salt, thus proving its presence in suints, and further studies have been made of its action in promoting the yellowing of wool. In addition, small amounts of amino acids (notably cystine, histidine, and tyrosine) also present in suint have been found similarly to promote yellowing of wool; in fact they appear somewhat more active in promoting yellowing than urocanic acid.

Plans

Efforts next will be directed towards more complete identification of other suint constituents that may be involved in yellowing of wool, as a basis for developing treatments or conditions for optimum storage of wool to minimize such discoloration.

(b) Yellowing Promoted by Light - Tetrabutyl titanate has been cited as a chemical agent highly effective in protecting wool against yellowing by long exposure to light. The titanate treated wools withstand many days of severe radiation with intense light without showing signs of yellowing, whereas untreated wools become yellow to brown under similar conditions. The titanate treatment is not washfast and is expensive with the present method of application, but the study of the protective action of this agent is valuable in throwing light on the mechanism of inhibition of the yellowing process. Present findings indicate that the protective action of the titanate against yellowing is due to the generation of free butoxy radicals by the action of the light on the tetrabutyl titanate and that the presence of these radicals in the vicinity of the light sensitive centers in wool blocks the yellowing reaction.

Plans

This study will assist in further work aimed to develop more stable and economical treatments for protection against yellowing. The work will consist of exploration of effects of additional reagents and treatments on wool yellowing and attempt to identify reactive sites in wool especially susceptible to yellowing.

2. Chemical Finishes Designed to Protect Wool from Strong Acids, Alkalies and Bleaches

ARS-WU

Wool is often required to withstand severe chemical environments, which degrade the fiber, for example, exposure to strong acids, caustics and bleaches. It is important therefore, that attention be given to finding practical finishing treatments for wool that will enhance its stability, particularly in view of the fact that resistance to degradation by such chemical environments is among the principal advantages claimed by synthetic fibers.

(a) Isocyanates - The properties of wool chemically modified with mono- and di-isocyanates have been studied in detail. These agents are found to confer a remarkable degree of protection against fiber breakdown by acid, and, in the case of treatment with di-isocyanates, against degradation by caustics and bleaches. Treatments with these agents are also effective in reducing felting shrinkage in laundering without imparting significant alteration in handle, wrinkle resistance and textile strength; but for complete shrinkage protection a considerable uptake is required. A principal disadvantage of the present treatment of wool with the isocyanates is the need for use of organic solvents, an operation not presently commercially attractive.

Plans

It is planned to attempt a modification of the procedure for isocyanate treatment that will permit padding onto wool from a water solution. It is possible that an economically sound treatment may be developed for some applications provided that the amounts of isocyanates required are not excessive. (These substances are commercial chemicals available in quantity.)

(b) Azides - The chemical finishing of wools with diazides has been further studied. The agents used were specially synthesized and include a series of diazides covering a wide range in molecular size. These agents interact chemically with wool to "vulcanize" it, that is, to tie together the constituent molecules into networks and thus increase the chemical stability of wool. By using diazides of differing molecular sizes, opportunity is afforded to find the most effective molecular size of the treating agent for improving wool properties. It is found that the smaller sized diazides confer a marked degree of protection against acids, caustics and bleaches, whereas the larger sized diazides fail to confer such protection, even though their reaction tendencies with wool are similar.

Plans

No further work on the diazides is contemplated at present because it seems probable that cost and availability of these substances and hazards in their use on a large scale will prevent commercial application.

(c) Bismaleimides - Work on these agents has been discontinued for the present in favor of studies of treatments of wool found more effective in imparting resistance to degradation by acids and alkalies.

(d) Epoxides - The chemical finishing of wool with several diepoxides has been further studied. In general, the treated wools have properties similar to those treated with the diazides; that is, increased stability to acids, caustics and bleaches. Also, the treated wool is whiter. The diepoxide treatment has the advantage over the diazides in that application can be made from water solution using conventional finishing equipment.

Plans

It is planned to extend studies of the diepoxide treatment and to consider larger scale trials of the most promising of the agents.

Publications

Crosslinking of Bovine Serum Albumin and Wool Keratin. J. E. Moore and W. H. Ward. Jour. of American Chemical Society, 78, 2414, 1956.

3. Chemical Finishes to Impart Shrink-Resistance

ARS-WU

An ultimate objective of wool researches is the production of minimum-care textile apparel items; that is, wool garments which may be machine-washed, tumble-dried, and require a minimum of pressing or other services before reuse. The development of wools having better shrink-resistance would be an important step in this direction.

(a) Treatment with Polyimine-Polyepoxide Mixtures - Among various resin finishing agents studied during the past year for imparting shrinkage resistance to wool, the treatment with polyimine-polyepoxide mixtures is among the best. This treatment can be applied by padding from water solution using conventional equipment. With 2 to 3 per cent uptake shrinkage is eliminated. The treated fabrics have good hand; a defect in this respect has been a serious drawback with many of the other resin finishes tested. The treated fabrics have not lost the typical water repellancy characteristic of untreated wool fabrics. This property is often destroyed in chemical finishing of wool, causing undesirable "wicking" of water. The new treatments exhibit excellent fastness to repeated launderings.

Plans

In view of the apparent advantages of the polyimine-polyepoxide and similar treatments for control of laundering shrinkage, further evaluation of cost and practicability of processing is planned with pilot plant investigation carried out on the most promising of these treatments.

(b) Modification of Wool with Chromium Complexes - Chromium complexes of certain fatty acids, and particularly the perfluoro fatty acids have been found to impart good protection against fabric shrinkage in laundering. These agents can be applied from water solution and they impart a high degree of water repellency. A disadvantage with these agents is the light green color imparted to the wool, but this may not be a problem in cases where the fabric is dyed to darker shades. A more serious disadvantage of these agents is their present relatively high cost.

Plans

No further work is contemplated at present on these chromium complexes.

C. COMPOSITION AND STRUCTURE OF THE WOOL FIBER

1. Structure and Stability of Wool

ARS-WU

Because quality differences in wools reflect fiber structural and stability differences, it is vitally important to gain more complete understanding of the wool fiber. Modern manufacture demands raw materials of uniform qualities and objective methods for distinguishing the quality differences.

The isolation of two kinds of spindle cells which make up the bilateral structure of the wool fiber has been described. The two classes of cells have now been separated from a number of wools of varying quality and from mohair. Continuing exposure to acid has been shown to cause systematic changes in their properties including chemical composition. We interpret these results as showing a relatively resistant high-sulfur protein forming a sort of scaffolding or reinforcing material in both segments of the fiber.

Plans

This work is being continued and will comprise an investigation of the composition of the several wool structures in relation to fiber crimp, and other important properties.

Publications

Density Gradient Resolution of Cortical Cell Fractions. W. H. Ward and J. J. Bartulovich. Textile Research Journal, 25, 899, 1955.

Molecular Kinetic and Chemical Properties of Wool Cortical Cell Fractions. W. H. Ward and J. J. Bartulovich. 30th National Colloid Symposium, Madison, Wisconsin, June 18-20, 1956. Pages 56-58.

The Heart of the Wool Fiber. Harold P. Lundgren. The National Wool Grower, 46, #1, 11, 1956.

To Understand Quality Differences - Wool Cells Separated. Harold P. Lundgren. The National Wool Grower, 46, #4, 20, 1956.

2. Color Evaluation of Domestic Wools

ARS-WU

Work has been initiated on development of an objective color evaluation procedure for wool, part of a cooperative research project with the Marketing Research Division, AMS, which is conducting a study of the economic importance of off-color in domestic wools, and with the Livestock Division, AMS, which is interested in color as a possible factor in the grading of wool.

It has been found that the Gardner Automatic Color-Difference Meter is a suitable instrument for the evaluation of wool color.

Color measurements have been carried out on wool tops from 46 lots selected from CCC stored stocks to represent characteristic wools from various wool growing areas of the U. S.

Plans

Further measurements will be made on scoured wool, carded wool, noils, skirtings, and core borings from the same lots. These samples will characterize the domestic wool clip in terms of color variation, and the objective measurements obtained will serve as the basis for the preparation of visual color comparators for the evaluation of off-color characteristics.

3. Effect on Wool Fiber Properties of Environmental Factors in the Production of Sheep

ARS-WU

Plans

Plans are being perfected for a comprehensive investigations (coop. APH) of fiber qualities of wools from genetically stabilized groups of sheep maintained at several geographic locations. These studies will get under way as soon as such details as geographic location, feeding conditions and participation of State Experimental Stations have been settled. Initial studies on the wool samples will be devoted largely to analysis of mechanical and color characteristics.

4. Mechanical Properties of Natural and Modified Wools

ARS-WU

(a) Effects of High Energy Radiation Treatments of Wool on Its Mechanical Properties

In view of the increasing number of reports of improved strength obtained in synthetic materials as the result of radiation treatments, further examination was made of wools treated with different types and degrees of radiation, including high energy electron bombardment and ultraviolet radiation. Although no cases of improved fiber strength were observed, the experiments indicate the possibility of using high energy radiation to promote desirable reactions in wool under radiation conditions which do not degrade fiber properties. Preliminary experiments indicate the feasibility of utilizing irradiation to help improve the binding dyestuffs or chemical finishes to wool so that they are washfast.

Plans

The foregoing approach requires much more study. (See Proposals for Committee Consideration)

(b) "Tender Wools"

Analyses of mechanical properties were made on two sets of wool fiber samples taken from a shoulder of a Romney sheep. The first set represented 6 months growth on a normal diet; the second set represented the growth for a similar period on a restricted diet such that the sheep was gradually losing weight. A period of six months elapsed between the sample growing periods so that both samples were grown over the same time of year.

No visual differences were observed in fiber crimp in the wet-out scoured samples, but the "deficient" wools were found to be 15 per cent finer in average diameter than the normal wools and gave abnormal load-elongation behavior. The load-elongation curves exhibit secondary yield points, reflecting regions of small diameter, or possibly, weak points of normal diameter; these secondary yield points are rarely found with normal wool. It appears that fluctuations of stronger and weaker sections occur along the length of the deficient wools.

Plans

No further work is contemplated during the coming year.

(c) Wool Structure in Relation to Fiber Supercontraction

A study has been made of the influence of degree of supercontraction of wool fibers on the energy to stretch the supercontracted fibers. Supercontraction is a spontaneous shortening in length of the wool fiber which occurs when wool is placed in solutions that break chemical bonds. It is important as an index of fiber soundness and of changes due to physical and chemical treatments. The maximum degree of supercontraction which can occur is about 40 to 50 per cent. The shortened fibers remain contracted after removal from the chemical environment and washing in water. It has been found that the energy required to stretch these fibers 30 per cent above their original length varies strikingly with degree of supercontraction. At first this energy falls very rapidly as the amount of supercontraction is increased up to about 2 per cent, above which it falls slowly as the degree of supercontraction is increased up to the maximum. The behavior suggests that at least two sets of stabilizing bonds prevent the wool fiber from supercontracting and these are similar in nature but differ in the ease with which they are broken by chemical reaction.

Plans

Make further study of the supercontraction process which may throw light on subtle structural differences in wools and help to explain certain textile quality differences.

(d) Frictional Properties of Wool Fabrics

The instrument which analyzes the sound produced when fabrics are rubbed has been further improved and used on comparison of fabrics and fabric treatments. Several factors affect the sound produced by a given fabric. For example, the wetting-out of a wool flannel shirting material, which raises the nap, decreases the sound intensity. Progressive abrasion of the flannel, which first raises the nap, decreases the sound intensity, and then as the nap is worn down, the surface friction increases and the sound intensity increases.

Plans

Continue work on measurement of frictional properties by sound analyses and to further improve techniques.

5. The Role of Trace Minerals in the Properties of Wools

ARS-WU

A research contract has been recently initiated at the University of Wyoming with the aim to determine the distribution of trace minerals in wools from selected representative geographical areas of the U. S. This study is planned to show what mineral elements, if any, are of practical importance in determining wool qualities such as color, and to show how clean fiber mineral content is related to the mineral contents of the adhering soil and grease.

6. Investigation of Specific Dyes and Other Stains to Reveal Differences in Wool Structures

ARS-WU

(a) Sodium Plumbite

Additional work has been done using sodium plumbite as a stain effected in revealing differences in the cortex of wool fiber. It is found that the rate of staining by this agent is markedly different for wools of newborn lambs; the birthcoats of twin Rambouillet ram and ewe lambs were studied and compared with wools of similar fineness from mature Merino and Rambouillets. The results indicate that a test based on plumbite staining might be developed to differentiate lamb's wool from wool of mature sheep. Such a test is needed by the wool processing industry.

Plans

Make further studies of plumbite and other stains for characterizing wool fiber differences.

(b) Ninhydrin

The literature reports that treatment of wool with ninhydrin, an agent which gives a purple stain to the fiber, results in new properties which indicate that crosslinking has occurred, that is, that the constituent molecules are tied together more tightly. Since

crosslinking can lead to improved fiber strength and stability, it seemed worthwhile to examine this reaction further; and the presence of the stain might assist in identifying the parts in the fiber involved. It was found that the treated fibers are stiffer, both wet and dry. This suggests crosslinking has occurred, but other tests fail to substantiate this contention.

Plans

No further work with this stain is contemplated.

7. Force-Temperature Analyses and the Stability of Propiolactone-Treated Wool Fibers

ARS-WU

Tests were made of the variation of equilibrium force with temperature of a series of wools treated with increasing uptake of propiolactone resin. As the amount of resin deposited within the fiber increases, the fiber behavior changes progressively from that typical of a normal solid, expanding with a rise in temperature, to that of a rubberlike material contracting with increased temperature. To account for this change in behavior of the treated wool it is supposed that the resin deposited in the fiber progressively wedges apart stabilizing links within the wool fiber to produce a more internally mobile structure, somewhat like rubber.

The greater flexibility of propiolactone-treated wools is a property tending to increase the ease of felting. Practical use of propiolactone in the industrial felt industry has been delayed because of the present relatively high cost of this chemical. Recently a felt hat company has expressed interest in the use of this agent for improving the felting of wool for possible use in hats.

Publications

The following patents on propiolactone treatment, assigned to the Secretary of Agriculture, have appeared:

Beta-Propiolactone Modification of Wool. W. G. Rose and H. P. Lundgren. Patent No. 2,717,194, September 6, 1955

Control of Static Electricity with Polymeric beta Propiolactone. H. P. Lundgren, C. H. Binkley and A. S. Yeiser. Patent No. 2,175,592, August 16, 1955

8. Dielectric Constant of Wool at Microwave Frequencies

ARS-WU

This work was concluded and the following publication has appeared:

Publication:

Microwave Dielectric Measurements on Single Fibers. J. J. Windle and T. M. Shaw. Textile Research Journal, 25, 865-870 (1955).

D. WOOL BY-PRODUCTS AND WASTES

1. Treatment of Wool Scouring Wastes

ARS-WU

The treatment of waste liquor from "desuinted" raw wool with colloidal bentonite has been investigated. The desuinting operation consists of a preliminary cold water wash of raw wool to remove the greater portion of the water-soluble impurities and dirt before the major scouring operation with soap or detergent and alkali at elevated temperatures. The desuinting wastes can be successfully clarified by treatment with 0.05 - 0.2 per cent bentonite based on volume of waste. The exact amount of bentonite required will vary depending upon the type of wool, ratio of water to wool employed in desuinting, and the grease content of the waste. This procedure for treating desuinting waste is distinct from that used for treating soap-soda or neutral nonionic scouring wastes requiring acid conditions for successful clarification. The clarified suint solution which is produced has been found to have useful detergent properties.

Preliminary laboratory scouring trials indicate the possibility of employing bentonite-clarified suint solution in conjunction with the neutral, nonionic scouring procedure to reduce the overall consumption of detergent. It appears that a substantial reduction in the amount of detergent, as much as 50 per cent, is possible by combining a suint scour in the second bowl with a nonionic detergent scour in subsequent bowls.

Studies have also been carried out on a modified acid scouring procedure involving the use of bentonite to clarify the waste liquor for recirculation to the scouring process since the clarified liquors have detergent properties. In the coagulation procedure, treatment of the acid scouring wastes directly with bentonite without the further addition of acid gives satisfactory clarification. The degree of clarification and rate of sedimentation of the precipitate varies considerably with the type of nonionic detergent used in scouring.

Among a number of nonionic detergents investigated, the non-aromatic ether and ester types show acceptable scouring efficiency and appear to be promising for possible use in a process involving acid scouring, treating the waste with bentonite, and reusing the clarified liquors for scouring. An undesirably large proportion of detergent has been found to be removed with the bentonite under certain conditions. Means are now being sought for controlling such losses.

Plans

Continue the study on treatments of wastes from scouring by a number of nonionic detergents under varying conditions of acidity and temperature.

Publications

Treatment of Wool Scouring Wastes with Colloidal Bentonite.
W. Fong. Textile Research Journal, 25, 994- 1000, 1955.

Run Sheep Run. Industrial and Engineering Chemistry 47, No. 12,
9A, 1955, Staff Writer.

Wool Scouring Causes Pollution Problem. The National Wool Grower,
46, No. 5, 30, 1955, Staff Writer.

2. Wool Grease

ARS-EU

Normally, when lanolin is subjected to fractionation by treatment with urea, about 6 - 8% of the original lanolin combines with urea. The material recovered after decomposing the urea is a hard wax-like product. From the remaining portion it was possible to obtain in 70% yield, a fraction which was fluid at room temperature. Experiments on lanolin were conducted to determine if the yields and properties of these fractions could be improved but it was found that they were increased to only 11% with no appreciable change in properties of the fractions obtained.

The investigations on the isolation and characterization of individual wool wax compounds were continued. The unsaponifiable portion of wool grease was fractionated by varying techniques but the distillation data gave no evidence of effective separation.

A phase of the work dealing with chromatographic trials with a small hydrocarbon fraction is being discontinued.

Several preparations of low ester number wool wax acids have been made and these compounds are to serve as starting material for metal soap investigations.

Publications

The Sodium Reduction of Wool Wax. Abner Eisner, John T. Scanlan and Waldo C. Ault. J. A. Oil Chemists' Soc. 32, 556-8 (1955).

Making Compositions. George C. LeCompte and Waldo C. Ault.
U. S. Patent 2,735,780 (1956).

PROPOSALS FOR
COMMITTEE CONSIDERATION

II. UTILIZATION AND CONSUMER USE

1. Comprehensive and Coordinated Investigations on Production of Sheep and Utilization of Meat and Wool.

(See Proposal No. 1 under PRODUCTION)

2. Mechanical Processing of Chemically Modified Wools

Initiate research, on a practical pilot-plant scale, on the mechanical processing characteristics of wools pretreated in selected ways, for example by adjustment of pH and by modifications which improve chemical stability and fiber mechanical properties, to assist development of improved wool textile products and more efficient wool manufacturing operations.

3. Wash-and-Wear Wool Garments and Furnishings

Expand research, both basic and pilot-plant, to develop permanent wool treatments so that woollen articles such as suits, slacks, shirts, dresses, skirts, knitwear and household furnishings, can be washed, dried and re-used in the home with little or no pressing or further servicing. More effective treatments would be developed for wrinkle- and shrink-resistance and for increased permanence of pleats and creases. Such an accomplishment would be a big step in the direction of establishing wool in a better competitive position with synthetic fibers.

4. Service and Protection of Wool Containing Items

Expand and where needed initiate laboratory research and pilot plant studies to develop economical wool treatments durable to use for dry- and wet-cleaning, that give adequate resistance to soilage and water. Such improved treatments are of utmost importance to broadening the utilization of wool in clothing, upholstery, floor coverings, and other items.

5. Methods for Carbonizing Wool

Initiate research to develop new improved procedures for carbonizing wool for more effective removal of vegetable contaminating matter. Current processing methods fail to remove all of these impurities so that it becomes necessary frequently to pick out these materials by hand, a costly operation. These studies should also seek ways to minimize damage to wool fibers during carbonizing and to lower processing costs. Pilot-plant studies should be made to evaluate the laboratory researches in terms of carbonizing effectiveness and the effects of such treatments on subsequent operations such as dyeing.

6. Bleaching Wool

Initiate a research program to develop new or improved products and procedures for bleaching wool, with the investigations particularly directed toward making possible the greater utilization of wools of widely varying initial color and condition in white and pastel-colored end-items. These studies should also seek ways to minimize damage to wool during bleaching operations and to lower the processing costs. Pilot-plant studies should be made to evaluate the laboratory research in terms of bleaching effectiveness and the effects of such treatments upon subsequent processes to produce durable pastel shades, resistance to shrinkage and insect damage, and other special characteristics, and upon the efficiency of mill operations such as combing, carding, and spinning.

7. Wool Felts and Felting Methods

Expand research to develop better understanding of the felting process, seeking ways to lower processing costs and to prepare felts having greater apparel and industrial utility, in order to assist the wool felt industry maintain its competitive position in the face of felts now made from synthetics having greater chemical resistance, heat stability and resistance to insects and microorganisms.

8. Surface and Internal Structure of Wool and Mohair

Initiate research on the application of conventional optical, phase contrast, and electron microscopy to wool and mohair with special attention paid to the study of the mechanism of soiling and deposition of chemical finishes. The information which can be obtained from these investigations is urgently needed to support researches in development of improved wool properties.

9. Crosslinkage Formation and Stability in Wool Fibers

Expand research on the formation and stability of new cross links in wool fibers, for example, by making use of new techniques for peptide bond syntheses. The information that might be obtained from these researches would be invaluable in guiding further development of improved wool fiber quality and stability.

10. Fastness of Wool Chemical Finishes and Dyestuffs

Determine whether high energy radiation treatments can be used economically to improve the fastness to washing and to sunlight of chemical finishes and dyestuffs. Preliminary tests have suggested that firm chemical binding of agents to wool may be achieved by radiation treatments under conditions which do not degrade fiber quality, but much further work will be necessary in order to determine whether the radiation treatment can be made of practical use.

11. Chemical Sizes to Increase Wool Processing Efficiency

Initiate research to develop and evaluate new chemical agents having properties suitable for sizing wool yarns with the aim of reducing warp fiber breakage and increasing weaving efficiency, thus lowering costs of processing so that wool can better meet increasing competition in the textile field.

III. MARKETING

A. COSTS AND EFFICIENCIES

1. Measurements and Analysis of Changes in Margins and Costs for Marketing Textile Products

AMS-MOC

This project is designed to show changes in gross margins and in items of cost included for cotton, wool, and other textiles and their products at each important stage in the marketing procedure; to indicate the relationship of these margins and costs to such factors as kind and size of the operating units, methods and practices of operations, and facilities and equipment used; to ascertain the relative importance, from the viewpoint of costs, of the agencies, services, equipment, and cost items involved; and to indicate means of bringing about needed adjustments.

During the past year data have been assembled to bring up-to-date information on margins and costs of wholesale and retail distribution of wool and other textile products. These data show that in 1955 gross margins for wholesale dry goods houses averaged about 16 percent of net sales and were smaller than for any other year, except 1953, since 1949. Profits also averaged smaller in 1955 than for any other year, except 1953, since 1949. Gross margins for department and speciality stores averaged 36.4 percent of net sales, and were wider than for any other year since 1950. These margins ranged from less than 30 percent of net sales for men's work clothing and for bedding and domestics to more than 39 percent for aprons and uniforms, misses coats and suits, maternity dresses, and handkerchiefs. Net profits from merchandising operations ranged from less than 30 percent of net sales for stores with annual sales of less than 1 million dollars to 4 percent for stores with annual sales of 20 to 50 million dollars. Net profits after Federal income taxes averaged less than 3 percent of net sales.

Plans

Additional data need to be assembled and more detailed analysis made to bring up to date and expand the information on margins and costs; to show the factors responsible for or associated with changes in these margins and costs; and to indicate means of increasing efficiency, reducing costs, and expanding market outlets for cotton and wool. Data from the census of manufacture and of business for 1954, which are becoming available, along with data from other governmental and private sources, will supply a basis for substantial expansion in research needed relating to this project.

2. Price Risks for Wool and Wool Products and Means of Reducing Them

AMS-MOC

This study was designed to (1) show the nature and extent of the risks of loss and possibilities of gain from changes in prices of wool, wool top, and selected wool yarns and fabrics; (2) ascertain to what extent

futures trading and alternative means afford protection by reducing or offsetting the risks of loss from price changes through hedging and other operations; (3) indicate the influence of various factors on the spot-futures price relationships and protection afforded by futures as hedges; (4) show gains and losses from transferring hedges and from straddle transactions; (5) indicate the effects of trading in futures on fluctuations in spot prices; and (6) give some indications of the effects of futures trading and other stabilization operations on the stabilities and level of wool prices, on costs of marketing, on incomes to producers, and on costs to consumers.

The basic data have been assembled, analyzed, and interpreted, and the results prepared for publication. The results show that losses and gains from changes in prices of wool over relatively short periods are sometimes as great as or greater than total costs involved in taking wool from farms and ranches and delivering it to topmakers and mills. The corresponding changes in prices of wool tops, yarns, and fabrics average greater than those for wool. Results of the research indicate that large proportions of the losses and gains from changes in prices of wool and wool tops, particularly when these prices were not stabilized by Government price support operations, could have been offset, and other costs of marketing and manufacturing wool and wool products could have been reduced, by the use of futures markets for hedging and for other purposes.

Plans

With the publication of the findings this project will be completed.

3. Improvements in Handling and Preparing Wool at Warehouses AMS-MCC

This study is designed to supply a basis for improving the adequacy and efficiency of warehouse operations and related services for wool by assembling and analyzing information to show (1) the nature and extent of the handling, preparing, and other services relating to wool at warehouses of various types and the charges or costs involved; and (2) the influence of the various factors on the adequacy and efficiency of these services and on their benefits and costs. The need for the results of such research is emphasized by the fact that domestic wool is confronted by greatly increased competition from well-prepared imported wool and from manmade fibers and that improvements in the adequacy and efficiency of the warehouse services appear to be a promising means of strengthening the competitive position of our wool.

Progress on this project has been limited mainly to the preparation of plans.

Plans

To resume this work as soon as adequate personnel can be obtained.

4. Analysis of Efficiency and Costs of Manufacturing Cotton and Wool Products

AMS-MOC

This project is designed to discover the most feasible means of increasing the efficiency and reducing the costs of the services rendered in specified segments or operations of the cotton and wool manufacturing industry. The research would involve detailed analyses for representative establishments to show the influence of the various factors on the efficiency and costs of specific processes under actual operating conditions, the preparation of specifications and operating costs for low-cost establishments for manufacturing specified products, and the use of the results shown under actual operating conditions and those indicated for model low-cost units to indicate the most feasible means of improvement. This research would need to be developed in cooperation with operators in the industry and with the assistance of agencies well trained in cost engineering in the textile industry. Because industry has been unwilling to cooperate, progress on this project has been limited.

Plans

As soon as needed cooperation from representatives of the industry can be obtained, studies relating to suitable phases of processing or manufacturing operations are to be initiated.

B. MARKET DEVELOPMENT

1. Women's Opinions of Cotton and Other Fibers in Selected Items of Clothing

AMS-MD

This study brings up to date certain information collected in 1946 on women's preferences for fibers in 15 selected items of clothing. Although the study is primarily focused on cotton, certain information is available on wool in these uses. For example, wool was first preference in skirts and dresses for winter wear. A final report has been published.

Publications

Women's Opinions of Fibers in Selected Items of Clothing. Preliminary Summary Report, AMS-11, February 1955.

2. Women's Uses of and Preferences for Wool and Other Fibers in Selected Items of Clothing, Home Sewing and Needlework Crafts

AMS-MD

This study was to ascertain ownership of suits, skirts, and sweaters by females 18 years of age and older. Factors governing their purchases, such as the fiber content of these items, preferences for

fibers, and attitudes associated with the selection of these items of clothing, were surveyed in the national sample of women. Also, attitudes on care and cleaning of these garments were ascertained. Other information was obtained on sewing, knitting, and other needle-work crafts in the home.

The interviewing and analysis phases of the study have been completed. Final reports are now being prepared for publication.

Publications

Women's Attitudes Toward Wool and Other Fibers in Suits, Skirts, and Sweaters. Preliminary Summary Report, AMS-115, April 1956.

3. Use Patterns of and Preferences for Fabrics and Fibers Among Automobile Manufacturers

AMS-MD

This study obtained data on the volume of the fabrics and fibers used in the manufacture of passenger cars and ascertained manufacturers' opinions about the use of these fabrics and fibers as well as their expectations as to what will be used in the future. The study covers fibers used in the interior trim of passenger cars-- cotton, wool, synthetic fibers, and other competing materials.

This study is a follow-up of a prior study conducted in 1950. The data collection, analysis, and preparation of the final report have been completed. The report is now undergoing clearance.

4. Fiber Preferences of Teenage Girls for Selected Items of Clothing

AMS-MD

This study obtained information on the various items of readymade clothing owned by teenage girls. Fiber content of present clothing items, fiber preferences, and attitudes about various fibers for clothing were obtained. Also, data on shopping practices and on the mother-daughter relationship in selection of teenage girls' wardrobes were obtained.

Interviewing, tabulation, and analysis phases of the study have been completed. The final report is now being prepared for publication.

Publications

Teenage Girls Discuss Their Wardrobes and Their Attitudes Toward Cotton and Other Fibers. Preliminary Summary Report, AMS-90, March 1956.

5. Men's Uses and Preferences Among Selected Items of Clothing

AMS-MD

This study is similar to one conducted in 1948 on men's preferences among selected items of clothing. It will obtain data on the competitive position of cotton in relation to other fibers used in

selected items of men's clothing (summer sport suits, slacks, dress socks, summer suits, robes, and Bermuda shorts). This information will bring out changes since 1948. In addition, data on shopping practices and attitudes toward new fibers and fiber blends, styles, and colors will be obtained. Since wool is an important fiber for some of these items, information as to its use and consumers' opinions about wool as a fiber in these items will also be ascertained.

A contract has been negotiated with a commercial market research firm for this survey. Interviewing is scheduled for early fall, 1956.

6. Consumer Use of and Preferences for Selected Cuts of Lamb

AMS-MD

This study had a twofold objective: (1) To evaluate consumer preferences for and attitudes toward fresh lamb, and (2) to measure the effects of promotional activities at the consumer level in terms of changes in both over-all and specific uses of lamb, as well as changes in attitudes and opinions. The surveys were conducted in Cleveland, Ohio, and Sacramento, California.

A report of the Cleveland study covering the first objective was published. Some of the more important findings are: Almost 5 in 10 homemakers in the Cleveland area used lamb in the preceding year and approximately 1 in 6 bought lamb during the week preceding the interview. Users liked lamb because of its distinctive flavor, its nutritive qualities, its lean tender texture, the ease of preparation, and the variety it adds to meals. Users disliked lamb because of its cost, tough greasy texture, strong flavor, and its odor during cooking. Preferred cuts of lamb were chops and leg of lamb. Non-users mentioned dislike of flavor and eating habits developed in childhood as important reasons for not using lamb.

Plans

The Sacramento study covering the first phase has also been completed and will be published as soon as the results of the second phase, which are now being processed, become available. The second phase of the Cleveland study will be conducted in the fall of 1956.

Publications

Homemakers' Preferences for Selected Cuts of Lamb in Cleveland, Ohio. USDA Marketing Research Report No. 113, March 1956.

7. Fiber Preferences in Household Textiles

AMS-MD

The planning on a consumer use and preference survey regarding the competitive position of wool, cotton, and other fibers in household furnishings has been initiated. Segments of both the wool and cotton industries have suggested the need for a survey of homemakers' experience with and preference for the various new and improved fibers

used in selected household textile items. New fibers contained in blankets, floor coverings, upholstery, slipcover, and drapery fabrics have been on the market long enough for a consumer study to yield valuable results.

Consumer attitudes toward and preferences for various fibers, especially the new fibers used in household textile items, are helpful to laboratories working on product improvement in this area.

Plans

This survey will be conducted under contract with a private marketing research firm and interviewing will take place in the spring of 1957.

8. Economic Problems Associated with Off-Color Wool

AMS-MD

The economic evaluation of coloration defects in scoured and semi-processed wools was begun during the year. Efforts were directed toward measurement of the degree and extent of color in wools after they have received the usual scouring bath treatment. Color measurements were made by WI on samples drawn from lots of CCC-owned wool, 46 lots of which were processed into top in 1955 and 21 lots of which were processed in 1956. The results of these color tests show the range of coloration defects in a cross section of domestically produced wool. A simple color comparator depicting this range of color has been made up. The comparator is a wool sample compression box, with a glass top on which color dots representative of the color spectrum found in the tested wools are systematically arranged. This unit permits a direct visual comparison of color between wool samples and the color-tested wool as well as showing the range of colors found in domestic wools.

Present efforts are devoted to collection of information from the wool processing industry, using a questionnaire and the color comparator in a series of interviews with a group of firms selected by random sampling. Using the color comparator as a yardstick of color measurement, industry members are being asked to give their estimate of the commercial value differences for wool of the various degrees of color defect shown by the color dots on the comparator. Also, samples of wool used by each firm are to be tested with the comparator to discover the relationships, from the standpoint of color, between wools used to make specific products and the cross section of domestically produced wools shown by the comparator.

When completed, this work will (1) define the color problem in terms of economic significance to the industry, and (2) provide indications to research workers on the economic feasibility of the development of various bleaching agents and other chemical modifying reagents for removal and prevention of color defects.

Plans

Because of differences in research techniques required and in measurement of the defects, present efforts do not include the black fiber problem. Work will be begun on problems associated with black fiber and black hair in wool as soon as it is feasible.

9. Effects of Advertising and Promotional Programs on Retail Sales of Lamb and Mutton AMS-MD

Research to measure the effectiveness of merchandising, promotional, and advertising programs on the sale of and consumer demand for lamb and mutton through retail food stores was conducted during the year. Advertising and promotional programs, conducted for the American Sheep Producers' Council, Inc., are being evaluated by means of retail store audits before promotion, during promotion, and after the promotion period has ended in Cleveland, Ohio, and Sacramento, California. Each audit covers a 2-week period of retail sales. Data were obtained on sales of lamb and mutton, retail prices, and display space allocated to lamb and mutton and to competing meats.

Plans

Analyses of data and publication of results obtained in the two cities will be made in the coming year.

10. Wholesale Distribution of Lamb and Mutton AMS-MD

Research was completed on work dealing with current wholesale distribution of lamb and mutton designed to ascertain where meat packers distribute their products. The study indicated that over one-half the lamb and mutton in 1954 went to the States of New York, California, and Massachusetts. New York and California each received more than twice as much lamb and mutton as any other State, their proportion being about 24 and 21 percent, respectively. However, on a per capita basis, lamb and mutton available for consumption in 1954 was highest in Massachusetts and California, with 12.4 and 12.3 pounds per capita, respectively. Other States receiving lamb and mutton in sizable quantities in 1954 included Pennsylvania, Illinois, New Jersey, and Michigan. These seven States accounted for 76 percent of the total U. S. supply of lamb and mutton. By contrast, less than 1 percent of the U. S. total was distributed to 10 States--Vermont, North Dakota, South Dakota, West Virginia, South Carolina, Alabama, Mississippi, Arkansas, Oklahoma, and Wyoming.

Plans

The work on this project has been completed and there are no further plans for work in this area.

Publications

Market Development Research Relating to Lamb and Wool. Harry O. Doty, Jr. Agricultural Outlook Conference, November 29, 1955.

Section 708 of the National Wool Act of 1954--Provisions and the Operations to Date. Harry O. Doty, Jr. Agricultural Outlook Conference, November 29, 1955.

Distribution of Lamb and Mutton for Consumption in the U. S. Harry O. Doty, Jr. AMS-93, February 1956.

Lamb and Mutton Consumption in U. S. Harry O. Doty, Jr. Marketing Activities, March 1956.

Mary's Lamb Followed Her--But Where Do Your Lambs Go? Harry O. Doty, Jr., Daniel B. Levine, and J. Scott Hunter. Agricultural Situation, Vol. 40, No. 4, April 1956.

Lamb Consumption by States. Harry O. Doty, Jr. The Livestock and Meat Situation, 83, May 9, 1956.

11. Retail Availability of Lamb and Mutton

AMS-MD

The purpose of this work is to ascertain the seasonal and geographic availability of lamb and mutton in retail outlets. Seasonal availability and availability of lamb and mutton by days of week in retail stores as well as certain merchandising practices will be determined. More complete knowledge of the retail availability of lamb and mutton will assist the industry in its distribution, advertising, and merchandising activities. Data on availability were obtained from a national sample of 6,000 retail food stores throughout the U. S. The data are now being analyzed for publication.

Plans

Additional work on retail availability of lamb is not contemplated.

C. QUALITY CONTROL

1. Protection of Wool and Woolen Products from Insect Damage

AMS-BS

These studies at Savannah, Ga., are directed towards the development of methods to prevent insect injury to wool or woolen products in trade channels or in the possession of the consumer, and techniques of application for use by the warehouseman, the manufacturers, launderers and dry cleaners, or the householder. Cooperative studies requested by the Army Committee on Insect and Rodent Control on methods of control for use by the Military are also carried on, and these often reveal new leads that can be adapted to non-military problems.

Further comparison of the use of lindane crystals in place of naphthalene to protect wool uniforms packed in cases and held in storage revealed that lindane crystals added at the rate of 5 grams per cubic

foot of volume in the cases, completely protected the uniforms for 3 years, and 35 percent of the lindane crystals still remained after 3 years. Naphthalene added at the rate of 46 grams per cubic foot had all volatilized by the end of the first year. Thus one treatment with lindane could remove the necessity of two annual replenishments of naphthalene, at a savings of 75 cents each year in labor costs to open each case. This is calculated to save the Quartermaster Corps over \$1,000,000 a year in maintenance cost alone, and insure better protection. Analysis of the lindane residue in uniforms so stored 4.8 to 13.3 mg/sq. ft. when unpacked, and 1.4 to 2.2 mg./sq. ft. after hanging in a storage room for 4 weeks. These levels are below those already established as harmless when resulting from applications to clothing for control of lice.

One-half fluid ounce of EQ-53, a non-ionic emulsifiable concentrated formulation of DDT, added to the final rinse in the wool scouring process (Coop. APH) for each pound of dry wool, resulted in a deposit of DDT that persisted through the carding and combing in sufficient degree to protect the wool from insect damage. Lots of wool were scoured, carded, and combed at Beltsville, and samples after each step were chemically analyzed and exposed to insects at Savannah. Further tests (contract Lowell Technological Institute Research Foundation) showed that DDT applied during the scouring process persisted through 13 subsequent manufacturing steps in making yarn in sufficient degree to protect against insect injury. These two studies have shown, therefore, that by a very simple and inexpensive process wool can be protected from insect damage in all stages from raw scoured wool to manufactured items.

Rolls of military uniform cloth treated with eight different "permanent" mothproofing agents applied during the dye bath, showed insect injury in varying degrees greater than rolls treated with DDT, after 3 years storage in a heavily infested storeroom. These tests were conducted to compare the protection rendered to uniform cloth during warehouse storage by these various commercial products and DDT. Mothproofing compounds applied in the dye bath usually resist removal by washing or drycleaning to a greater degree than does DDT.

Plans

Work will be continued to find adaptations for mothproofing with EQ-53, and to evaluate the longevity of DDT in storage tests. New studies are planned to develop methods of applying mothproofing treatments as a part of commercial dry cleaning procedures, in cooperation with industry groups.

Publications

Clothes Moths and Carpet Beetles - How to Combat Them. USDA Home and Garden Bulletin 24, Revised November 1955.

D. ECONOMICS OF MARKETING

1. Current Situation and Outlook Analysis for Wool

AMS-AEc

This work appraises the current and prospective economic position of wool and related competitive fibers to aid farmers in their management decisions.

Analyses of the factors affecting supplies, prices, and utilization are directed toward meeting requests for information relating to these commodities. The appraisals of the economic position of the commodities are revised regularly to reflect changing conditions and new developments. The results of the analyses are made available to the public through The Wool Situation, The Demand and Price Situation, The Agricultural Situation, and other reports and publications of the Department.

The results of an analysis of cyclical movements in mill use of apparel wool during the postwar period were published in the October 1955 issue of the The Wool Situation.

A handbook of long-time statistical series and other data indicating basic trends affecting production, stocks, trade, consumption, and prices of wool, mohair, and related and competitive fibers was published in 1954. The first supplement, designed to bring the statistical series in that publication up to date, was released early this year. It is planned to issue such a supplement each year. The 1956 supplement is now in process of preparation.

Publications

The Wool Situation (4 issues a year)

Supplement for 1955 to Wool Statistics and Related Data.

The Cycle in Mill Use of Apparel Wool During the Postwar Period.
Albert M. Hermie. The Wool Situation, TWS-33, October 1955.

2. Analyses of Demand for Wool and Other Fibers

AMS-AEc

Work is going forward in the analysis of economic demand relationships for the textile fiber economy. The objective is to obtain quantitative measures of these relationships. In addition to wool, cotton and the man-made fibers are receiving major attention.

A stumbling block to a full statistical solution of the problem is the lack of sufficient or adequate data on several crucial economic factors relating to the textile industry. For example, little or no reliable data are available on physical stocks of textile products by fiber type at the various levels of manufacture and distribution between mill and consumer. The importance of changes in these stocks on mill demand for wool cannot be underrated.

Analysis of limited data from industry sources on stocks of and unfilled orders for selected woolen textiles at the mill indicates that a 10 percent change in the stock-unfilled order ratio is associated, on the average, with about a 4 percent change in the opposite direction in mill consumption of wool. An assessment is being made of these and other inventory data to determine their suitability in the full analysis, important segments of which it is hoped will be amenable to statistical solution.

In connection with the study, work is near completion on a revised and extended statistical series on the fiber equivalent of imports and exports of wool textile products. These series will be presented and described, along with those for cotton and manmade fibers, in a report to be submitted for publication within the next year.

3. Current Situation and Outlook for Livestock and Meat

AMS-AEc

Outlook work on livestock is concerned with evaluating and reporting current and prospective trends in the livestock industry. Strong consumer demand for meat, increasing supplies and lower prices of feed, and emphasis on livestock as a source of income lifted livestock production and meat output to record highs in 1955. Output continued large the first half of 1956. In the second half it will fall short of the same period of 1955, though the year's total will set a new high.

Plans

To continue outlook work on livestock with stress on making it reliable and useful. Increasing attention will be given to regional aspects of the outlook.

4. Factors Affecting Price of Meat and Meat Animals

AMS-AEc

This project is designed to improved our basic knowledge of the factors that influence the production and price of meat animals and meat. This is a continuing project and serves as a background for outlook work and other current studies.

Plans

Continuation of this project with particular emphasis on studies of intercompetition between meats and on short-term influences on prices. Sufficient data for postwar years are now available to aid this analysis, and results of the 1955 consumer purchases study will be used.

PROPOSALS FOR
COMMITTEE CONSIDERATION

III. MARKETING

1. Control of Insects that Infest Wool and Wool Products

Expand research on the control of insects that infest wool and its products, to develop economical treatments to give wool adequate resistance to insect damage, to include the development of methods of applying mothproofing treatments as a part of dry cleaning processes and the incorporation of DDT into rug shampooing processes. Segments of the industry are quite interested in this research and have offered cooperation.

2. Objective Measurement of Quality Factors

Expand research to develop instruments and objective tests for important quality factors of wool to include rapid and simple methods of evaluating the susceptibility of raw wool to damage that may occur during processing and marketing. Although it is generally considered that the quality of wool may be defined completely in terms of the physical shape characteristics of the fiber, important differences exist even among physically similar wools in their susceptibility to this damage. At present, the determination of this susceptibility requires laborious chemical analyses and fiber mechanical studies. There is need for a rapid and simple method of evaluating this characteristic.

3. Consumer Reactions to Automobile Interior Fabrics and Upholstery

Initiate a consumer survey dealing with automobile owners' attitudes about and preferences for fibers and fabrics used in car interiors. With the design and fiber content of car interiors changing so rapidly, it seems important to assess consumers' acceptance of the new designs, the new fiber and fiber blends and other materials, and the new colors and patterns.

The Department has been contacted by a wool mill interested in establishing a good level of wool consumption in car interiors. This industry voice has expressed the view that a great need exists for a survey on consumers' attitudes about fibers and fabrics in car interiors as well as the information from the car manufacturers. Consumer attitudes about fibers and fabrics, and related information should be useful to laboratories working on improving fabrics for this end use. The need for such information is especially important since synthetics are making inroads on wool and cotton in car interior fabrics.

4. Fiber Preferences in Men's Suits, Coats, Topcoats, and Overcoats

Initiate research to determine, on a national sample, men's ownership of suits, coats, topcoats, and overcoats, fiber content of these items of clothing, and fiber preferences. Such a survey would bring up to date the types of information previously published, as well as provide needed information on men's attitudes toward and acceptance of the new fabrics, new styles, and colors which have come into the men's clothing picture since 1951.

This survey would be useful to those segments of the wool industry interested in having an assessment of wool's position in these end uses and to those interested in planning advertising and promotional programs.

5. Retail Merchandising Methods and Practices

Initiate pilot research to appraise retail merchandising practices for men's and women's apparel and retail piece goods containing 100 percent wool, mixtures of wool and synthetics, and 100 percent synthetic fibers.

A selected sample of department store buyers will be interviewed to ascertain particular problems in selling men's and women's apparel and piece goods, suggestions for improvements in promotion and advertising and for better methods of merchandising for wool and wool blends.

6. Competitive Position of Wool and Man-Made Fiber

Expand research to analyze changes in the relative amounts of wool and man-made fiber used in the manufacture of items for which wool traditionally has been considered the most desirable raw material and the factors associated with these changes. Although some work is being done along this line, the nature and extent thereof is seriously restricted by the inadequacies of available historical data and other information. Expansion of the collection of production data for the various end items is essential to this research. Such data is essential to a determination of the qualities of the various fibers involved.

7. Relation of Fluctuations in Retail Sales of Wool Products to Production at Earlier Stages and Relation of Prices to Buying Movements

Initiate research to determine the extent to which the contraction and expansion of inventories at the various stages of marketing, processing, manufacturing, and distribution are a factor in the extreme and somewhat erratic fluctuations in demand for raw wool, in mill consumption, and in prices. Research along this line would need to be preceded by the collection of information on prices, production, sales, and inventories at the various stages of production and marketing.

8. Outlook Work for Wool, Livestock and Meat

Expand the outlook information being made available, preparing it in the form and language most directly usable by State Extension workers and others. This would include more attention to regional reporting of the outlook.

9. A Consumer Panel in a Large Metropolitan Area

Initiate a consumer panel in a large metropolitan area by which data can be obtained, making it possible to have continuous and comprehensive evaluation of food product advertising, promotional programs, merchandising innovations, and new product introductions. Household purchase data would be obtained by size of purchase, frequency of purchase, average price paid, and proportion of families buying for all red meats, including lamb and lamb products. Also, data would be obtained through the consumer panel which would yield detailed food purchase records to supplement national and regional studies of the consumption habits and attitudes toward food and nutrition. Data obtained through the panel would also provide numerous by-product benefits in the form of comprehensive information on the trends in use of new forms of foods and food services, such as frozen and concentrated foods and food packaging.

10. Measurements and Analysis of Changes in Margins and Costs for Marketing Textile Products

Expand work on margins and costs on the basis of 1954 Census data and other information from private and public sources to bring up to date and expand the data to show margins and costs for textile products at each important stage in the marketing procedure and the items of cost included; to show the factors responsible for or associated with changes in these margins and costs and the relative importance of the items included; and to indicate means of improvement.

11. Handling and Preparing Wool at Warehouses

Expand research to improve the adequacy and efficiency of warehouse operations and related services for wool. Information is to be assembled and analyzed to show (a) the nature and extent of the handling, preparing, and other services relating to wool at warehouses of various types and the charges or costs involved and (b) the influence of the various factors on the adequacy and efficiency of these services and on their benefits and costs.

12. Efficiency of Processing or Manufacturing Operations for Wool Products

Initiate research to discover the most feasible means of increasing the efficiency of the services rendered in specified segments or operations of the wool processing or manufacturing industry. This research would need to be developed with the assistance of agencies well-trained in cost engineering in the textile industry as well as the cooperation of operators.

13. Consumer Attitudes Toward Imported Wool Fabrics and Garments

Initiate a study of ownership of and attitudes toward imported fabrics and garments. Both men and women would be interviewed, and information would be obtained on the extent of current ownership by various population groups. In an attempt to separate the aura that may surround imports from realistic considerations of wear, cost, appearance, etc., both owners and nonowners would be asked their opinions of imports and the comparative merits of imports and domestics, and owners especially queried on basic reasons for purchase, the recency of their experience, and their opinions of imported fabrics and garments after use.

IV. MARKETING SERVICES AND EDUCATION

A. FOREIGN MARKETING SERVICES AND RELATED RESEARCH

1. World Wool Situation

FAS

The current outlook is favorable for a continuation of the rising trend in world wool production. World production in 1956 is estimated at 4,865 million pounds, greasy basis, compared with the revised estimate of 4,685 million pounds in 1955. This marks the ninth year of consecutive increases in the world's output of wool. In recent years production in many countries has been stimulated largely by a natural desire for increasing foreign exchange earnings, the need for increasing domestic requirements and to profitableness of the sheep enterprise.

Substantial increases in wool production are reported for Australia, Argentina, and U.S.S.R. in 1956. The increase in Australia may be attributed to the dependency of the national economy on wool for export earnings, to pasture improvement, and continued favorable growing conditions. The carrying capacity of pastures in Australia has been considerably enhanced by the mass eradication of rabbits. According to reports, it is indicated that the U.S.S.R and Argentina anticipate an increase in wool production in 1956 which is most likely due to increasing domestic requirements in the former and the desire of the latter country to increase its export earnings.

The increase in production in Argentina reverses the trend of recent years. The new government policy has created a very favorable "climate" for wool production. Growers reportedly are holding back their new crop of lambs for wool production due to the favorable prices resulting from the upward revision in exchange rate for exports of wool which went into effect at the end of 1955. Trade sources indicate that the increase will be proportionately larger for coarse wools.

In New Zealand, a major wool exporting country, the prospects are for a further moderate increase in production in 1956. Better management practices and aerial top dressing of pastures have been among the major factors contributing to an appreciable expansion in New Zealand's output of wool.

In most of the other wool producing countries the recent trend indicates that production will be maintained near current levels or increased. Increases in production, primarily in the major exporting countries, contributed to a lower level of wool prices in 1955. The lower prices in the latter part of 1955 may have been the principal factor in stimulating mill interest in wool.

World wool consumption has been estimated at 2,620 million pounds, clean basis, in 1955 compared with 2,550 million pounds in 1954. The most marked increases in consumption occurred in the United

States, Western Germany and Japan. The increase in the United States, although substantial resulted in a level of wool consumption below that of earlier postwar years. In Western Germany and Japan new postwar records were established. In the United Kingdom and a number of other consuming countries, consumption was slightly more than in 1954, but in France and Italy moderate declines occurred.

Consumption of wool in eleven major consuming countries for the first quarter of 1956 is estimated to have increased by 5 percent compared with the previous quarter and 10 percent when compared with a year earlier. When an allowance for time lag in shipping, etc., and the upward trend in consumption is considered, it would appear that world production and consumption remains in close balance.

World consumption of wool might be further stimulated by a continuation of the present flow of the world's increasing supplies from producer to consumer areas. It appears that export surpluses will continue to move readily into trade channels.

The new export programs in Argentina and Uruguay are designed to prevent an excessive carry-over of wool in those countries, while the bulk of the Southern Dominion's wools normally are moved into export channels during the growing season.

In the Middle East countries limited restrictions are continued with respect to quantities as well as types available for export. Marketing programs are being developed in some of these countries which probably will result in an orderly movement of more uniform qualities of wool into the export channels.

B. DOMESTIC MARKETING SERVICES OF USDA

1. Wool Standardization

AMS-LD

The overall objective of this work program is the development of new or improved grade standards for wool, wool top, mohair, and mohair top. It also involves various studies of the characteristics of wool and mohair fibers - fineness, length, color, crimp, elasticity, strength, etc. - that are essential in identifying and evaluating fiber properties that can be used in the establishment of grade standards.

(a) Fineness and Distribution Specifications for Wool - Results from processing domestic grease wool into top have established the relationship between fineness of raw wool and the fineness and distribution of top, and further provided the bases for proposing a revision of the official grades of wool in 1955.

A study (coop. CSS) of 46 lots of CCC wool was largely completed in 1955. These data generally confirmed the proposed standards. The study was extended to include 21 additional lots of CCC wool representing different grades and some different geographical areas of

production from that sampled the previous year. Each of the 21 lots was equally divided into two groups and one-half of each lot was processed as original bag or graded only according to the original preparation, and the other one-half was commercially skirted, removing the tags, stained, low ends, and black gray, or brown. This should yield useful information relative to the influence of skirting on grade of grease wool and the resultant top.

Plans

The analyses of data from the 46 lots of CCC wool are nearing completion and will be published at an early date. The testing of samples from the 21 lots of wool collected in 1956 will be completed and the results analyzed to determine the effect that various methods of preparation for market have on grade and quality factors and the effect of skirting on grade and quality of top produced. Additional work will be conducted on characteristics of woollen and carpet type wool and the application of the proposed grade standards to these wools.

Publications

Fineness Relationship of Raw Wool, Top, Noil, and Percent Noilage. Pohle, Johnston, Ray, Mueller, Reals, and Manning. March 1956, U.S. Dept. of Agr. A.M.S.

USDA Proposes New Wool Grades. Elroy M. Pohle. National Wool Grower, Vo. 46, No. 6, p. 14-17, June 1956.

Report on Proposed Revised Wool Standard Specifications to A.S.T.M. Committee. Elroy M. Pohle, October 1955 and March 1956.

(b) Length Specification for Wool - Work on length of fiber was continued with the primary objectives of developing (1) length specifications for wool, (2) a suitable technique for sampling bags of grease wool for staple length, and (3) method of measuring staples.

A wool staple sampling tool developed and used for drawing grease wool staples produced highly repeatable results in the study of 46 lots of CCC wool. The data obtained from this study will provide the basis for a sampling schedule to be used in recommending the number of staples to be drawn per bag and the number of bags to be sampled for lots of different grades of various sizes. Results indicate that more staples are required for medium and coarser grades than for 80's to 60's for the same degree of accuracy. A recommended sampling schedule and measuring procedure will be published. The determination of staple length on the 21 lots of CCC wool will be completed to determine the effect of different means of preparation on length.

(c) Color Standards - Subjective color appraisals were made by the industry committee in 1954 on the 46 lots of grease wool processed into top as an initial step in evaluating color. The evaluation for color was made in conjunction with character; therefore, a specific rating for color alone is not available. However, samples of all top from the CCC wool used in the past processing work are being examined (coop. MD and WU) for use toward developing a suitable means for the objective determination of color.

Plans

When the techniques for measuring color variations are suitably developed, it is proposed to correlate this work with subjective appraisals and to develop color standards for scoured wool, pulled wool, and wool top.

(d) Strength - Preliminary tests are under way using a strength testing machine toward the development of a suitable method of differentiating between wools of various strengths and to relate these findings to other fiber characteristics.

Plans

The work on strength of fiber will be continued and work will also be initiated on other physical characteristics such as crimp and elasticity in an effort to develop standards for other utility factors in wool.

(e) Clean Fiber Content Through Objective Sampling and Testing of Grease Wool - Work toward improvement and simplification of the objective core-boring method of determining yield is under study. Emphasis is placed on (a) sampling and sub-sampling techniques, (b) testing the samples in the laboratory, (c) relationship of core yields to mill scoured, card sliver, and top-noil-waste yield.

Results of core yields and mill top-noil-waste yield in the cooperative study involving 46 lots of CCC wool indicate the 1-1/4 inch core more accurately reflected the actual mill top-noil-waste yield for the lots than did those samples drawn with the 3-inch or 3/8-inch pressure tube, and was considerably more accurate than the visual appraisal method. Both the 3-inch and 3/8-inch coring tube: tended to overestimate the yield.

Various coring patterns and the 1-1/4 inch and 3/8-inch tubes were used in sampling the 21 lots of wool processed in 1956. Scoured wool weight, combed ball weight, and weight of top-noil-waste were obtained for each lot and will be compared with core yields.

Plans

The adequacy of a new machine for sub-sampling cores of wool in the laboratory will be tested and, if practical, standard methods and techniques for its use will be developed. A proposed USDA standard

core testing method with procedures for analyzing samples of domestic wools will be prepared and published.

Publications

A Study of Core Sampling Tools, Methods, and Techniques. Wool Laboratory Staff. USDA-AMS-82, April 1956.

2. Lamb and Mutton Standardization

AMS-LD

The primary objective of the standardization work on lamb and mutton is the development of standards for carcass meats that objectively reflect differences in both palatability, and yield and proportion of salable meat; the development of grade standards for slaughter classes that are highly correlated with the respective carcass grade; and the development of grades for feeder lambs that can be satisfactorily used as a guide to their slaughter grade potential.

During the past year, the collection of cutting data was completed on 320 lamb and mutton carcasses as a part of the study designed to evaluate the influence of conformation and finish on carcass yields of both wholesale and retail cuts, and also to furnish data for yields of the various grades of lamb and mutton. Over 37,000 observations, measurements, and yields were obtained. Data were accumulated on three different styles of cutting and trimming of retail cuts. The data are being transferred to IBM cards at the present time to provide for future machine analyses. These results will be used to evaluate and revise, if indicated, the current grade standards for conformation and finish.

The grade standards were demonstrated and discussed with various segments of the industry at six meetings of national or regional scope. As a result of various industry discussions, a proposal for certain revisions of the grade standards for Choice grade lamb was made to the Department for consideration. Also, as a result of these meetings, an industry request was forwarded to the Department for a study of factors influencing palatability in lamb. This study is proceeding as an inter-agency project.

Publications

Federal Grading and Its Value to the Sheepman. J. C. Pierce. National Wool Grower, Vol. XLVI, No. 4, p. 10-11, April 1956.

3. Reporting and Statistical Service on Sheep and Wool

AMS-AEs

During the past year considerable emphasis and effort was put on monthly and seasonal wool price estimates and in reviewing the sheep and wool estimates for the 1950-55 period following release of data collected in the 1954 Census of Agriculture. The regular schedule of reports relating to sheep and wool continued, except for a special

release on June 21, 1956 which announced the average price received for wool for the 1955 marketing year. This price was used in computing the rate of the incentive payment for wool in connection with the National Wool Act of 1954.

Arrangements were made with CSS to summarize the applications for wool payments under the National Wool Act of 1954. County tabulations of such applications were forwarded by the State A.S.C. offices to the State Agricultural Statistician in each State. At the same time, arrangements were made with cooperative wool marketing associations throughout the U. S. to obtain detailed data by State of origin of the amount of wool sold and price received for wool by months for the 1955 marketing year. This was done in order to arrive at accurate final monthly estimates of prices and quantities sold.

To strengthen the current mid-month estimates of wool prices, State Statisticians of Agricultural Estimates have extended their field contacts with wool handlers, dealers, and cooperative marketing agencies to obtain current information on market prices and developments. Supplementary wool price and marketing information has been developed through national and regional marketing agencies.

Sheep and wool estimates for the U. S. during the period 1950-54 were revised upward only slightly as a result of the 1954 Census enumeration. The Census showed 361,000 farms reporting sheep in 1954 compared with 320,000 in 1950. Shorn wool production estimates were also revised upward slightly. For example, the 1954 estimate of U. S. sheep shorn was raised a little less than 1 percent and the U. S. average fleece weight was pushed up .04 pounds, with shorn wool production raised about 3.2 million pounds, a revision of about 1.4 percent. Changes in other years of the period were less than for 1954. Revisions in lamb crop estimates were correspondingly small for the U. S. Somewhat larger revisions were made for sheep and lambs on feed for market.

4. Cooperative Marketing of Wool in the United States

FCS

Work on this educational bulletin was completed and the manuscript is in the hands of the editors.

Plans

No further work is planned on this project.

5. Organization and Operations of the National Wool Marketing Corporation and Affiliated Cooperatives

FCS

The purpose of this study is to discover ways and means for improving the organization and operations of the cooperative wool marketing associations. Some of the findings of the study will be of significance to not only cooperatives, but also to growers, warehousemen, merchants, manufacturers and others in the wool trade.

A survey is underway to obtain the suggestions and ideas of manufacturers on ways and means for improving domestic wool marketing in (a) preparation of wool for market; (b) appraising, describing, sampling and testing; and (c) deferred pricing, price risks, and assured sources of supply. Results of this survey may be of general significance to growers and the wool trade.

Plans

Sub-projects will be initiated after completing the manufacturer survey. The type of sub-projects will depend on findings and results of previous work.

PROPOSALS FOR COMMITTEE CONSIDERATION

1. Development of Tolerances for Pigmented Fibers in the Various Grades of Wool

Expand studies designed to measure the incidence of colored fibers in wool and to determine the feasibility of establishing tolerances that would permit the use of this value influencing characteristic as a grade determining factor. This would involve a study of sampling techniques which is basic in the uniform application of proposed grade standards with fiber pigmentation as a grade factor.

2. Variability of Fiber Length in Grease Wool and Resulting Top

Expand work to determine the changes which take place in staple and fiber length in scoured wool, carded, and wool top to facilitate the development of length specifications for the different grades. Initiate research to determine variability of fiber length in individual fleeces, the anatomical and physiological bases for such variability, and the extent to which variability in fiber length of wool tops may be due to variability within and between fleeces, or to weak fibers or breaks in the wool. The results of this research will provide a more sound basis for improvement of wool and in determining the value and utility of wool.

3. Improvements in Statistical and Reporting Services

Improvements needed in statistical and reporting services include:

(a) More exact measurements of year to year changes in the number of farms keeping sheep and shearing wool and in the number of sheep and lambs on feed or shorn in feed lots. Sharp changes taking place make it extremely difficult to estimate accurately the changes in sheep feeding and feed-lot shearing and to keep up with the trends in native sheep States. Data being collected on lamb marketings under the wool program would be helpful in the estimating program, but resources are lacking with which to make detailed extensive tabulations of such data.

(b) Decennial statistics on breeds of sheep on farms and ranches and the number of purebred sheep. This is part of a broader project to provide such data on all species of meat animals and poultry. A reporting service in this field would provide State agricultural colleges, breeder associations, animal husbandmen, and others with a better basis for planning breeding and educational programs.

(c) Additional information on wool prices and marketing costs and more comprehensive surveys on wool marketing. Extreme variations in times of contracting sale and delivery of wool, along with fluctuations in the methods of sale and quantities handled by co-operatives and pools, complicate the problem of making accurate monthly and annual price and marketing estimates. Data from the accounts of sale filed by applicants for wool incentive payments contain a fruitful source of information on marketing costs, but a more complete analysis than has been authorized so far would contribute greatly to improvement in price estimates and to cost and margin analyses. Suggested steps for improving current price estimates would involve further increase in field office resources for making contacts, and for developing and analyzing more complete data from wool buyers and cooperatives and from data associated with the present wool program.

C. STATE DEPARTMENTS OF AGRICULTURE MARKETING SERVICE

1. Service Work by State Departments of Agriculture

AMS-IO

During the past year 6 State Departments of Agriculture and Department of Markets carried on marketing service activities relating specifically to sheep and wool. The programs in these States were concerned primarily with the promotion of the sale of breeding stock, lambs and wool on a graded basis at the local market level and assistance in the organization and operation of the marketing agencies, pools and special sales through which these commodities were marketed. Kentucky included sheep in its livestock conservation program, conducted a lamb promotion program, and disseminated information of a local and area nature on lamb and wool prices and other marketing factors. The service programs of the various States are described below under appropriate headings and in greater detail.

(a) Collection and Dissemination of Basic Data and Local and Nearby Marketing Information - In Kentucky, the State Dept. of Agr. prepared and disseminated to producers and buyers a weekly report on prices being paid for wool at various points in the State. This service was provided since producers did not have a source of information which accurately reflected prices at local points. The reports have improved the competitive situation for wool and tended to stabilize prices at local market points.

Kentucky also issued during the year a series of stocker and feeder bulletins which provided producers with information (by sex, age, breed and State of origin) on the stocker and feeder market, and on feeder lambs, replacement ewes and rams for sale at the various stockyards over the State.

(b) Technical Assistance to Local Marketing Agencies - In Kentucky assistance was again provided livestock producers, auction operators and haulers in improving facilities and methods of handling sheep and lambs so as to reduce costs and carcass damage from bruising.

(c) Improving Methods and Practices of Marketing Sheep and Wool - Most of the States conducting sheep and wool marketing service programs included activities designed to improve the tying, sorting and grading of wool. In Maryland, five area meetings were held ahead of the wool marketing period at which proper methods of folding, rolling and tying fleece were demonstrated, and methods of storage, handling and grading according to official USDA grades were explained. Approximately 90,000 pounds of wool moved through the several assembly points organized by the Maryland Department of Markets. This wool was marketed cooperatively and it is estimated that the program, through its effects upon competition at local points, increased returns to Maryland wool producers by nearly \$25,000 on the 264,000 pounds produced in 1956.

Assistance was provided in North Carolina in operating a statewide wool pool through which about 116,000 pounds of wool were handled for over 700 producers and in conducting 21 lamb-pools through which about 8,000 head of lambs were sold. These lambs returned to the producers from 2 to 4 cents per pound over prices for small lots sold at livestock auctions in the area.

Tennessee initiated a program of demonstrating the grading of lambs at the 12 lamb pools operated. This service was provided for the purpose of bringing about uniformity and consistency in grading results. About 25,000 lambs were graded in the course of these demonstrations. This program had the effect of improving lamb prices in sections of the State having the reputation of being poor lamb markets.

Virginia has sponsored two sales of graded stocker ewes in the State to demonstrate the advantages to both seller and buyer of marketing breeding stock on an organized basis. The 1,248 ewes sold at these sales were graded into uniform lots as to age, quality and condition, and returned the sellers about \$2 per head above prevailing field prices. Producers needing replacement stock were able to acquire their needs with a minimum of trouble and expense.

(d) Expanding Market Outlets - Kentucky was the only State under the AMA matched fund program that conducted a promotional program to expand market outlets for lamb. The Governor proclaimed July, 1956, as "Eat More Lamb" month. This proclamation was backed up by a promotional campaign under which marketing specialists called on restaurants, hotels and retail stores over the State to enlist cooperation and to provide assistance.

PROPOSALS FOR
COMMITTEE CONSIDERATION

1. Expand service work conducted by State Departments of Agriculture with emphasis on the following activities:
 - (a) Promotion of the sale of sheep and wool on a grade basis, and encouragement of better handling practices in marketing channels.
 - (b) Assistance in organizing effective agencies and in improving the operation of existing facilities for the marketing of sheep and wool.
 - (c) Promotional assistance in expanding market outlets for lamb.
 - (d) Providing producers with better information upon which to base marketing decisions.

D. MARKETING EDUCATION BY COOPERATIVE EXTENSION SERVICES

1. Sheep and Wool Marketing

FES

Only a part of the extension work in sheep and wool marketing is financed with Agricultural Marketing Act funds. During the fiscal year 1956 there were sheep and wool marketing projects in Colorado and New Mexico. In addition there are livestock marketing projects in 21 other States, several of which include work on sheep and wool marketing. Extension work in sheep and wool marketing involves helping people to solve their problems. The procedure involves assisting them in analyzing the situation, identifying the problem, pointing out alternative solutions and their possible consequences. After the people concerned determine the alternative they wish to take in solving their problem, assistance is given them through educational means in the solution. Following are examples of the work.

Work in Colorado has emphasized bringing about a greater understanding and use of grades, pricing, and other marketing information; encouraging effective and orderly marketing of sheep and lambs, and reducing losses from shrinkage. During the past year 21 demonstrations were conducted as a means of encouraging the grading and marketing of lambs in uniform lots. One grower reported that as a result of grading and selling in uniform lots, he received 2 cents per pound more than he would have otherwise received for 4,000 lambs. Assuming an average weight of 60 pounds per head, this grower received \$4,800 more than he would have received had he not marketed his lambs on the basis of grade.

The wool marketing work in Colorado is directed at improving preparation of wool and marketing on a graded basis. A wool and lamb improvement program is in operation in which breeding stock is selected on a production basis for grade quality. In 1954, approximately 20,000

head of sheep were in this program and in 1955, the number had increased to over 75,000. Results of this program are encouraging. One cooperator with 6,000 head of sheep who followed recommended practices in preparing and marketing his wool reported that he received 8 cents more per pound, or assuming an average weight of 9 pounds per fleece, \$4,320 more than he would have otherwise received.

The wool marketing program in New Mexico is directed at establishing improved methods of preparing and caring for the wool from shearing time to the warehouse and in reducing marketing costs. Work is directed at improving the quality and uniformity of wool. Uniformity of grade within fleeces eliminates sorting costs at the mill and packaging of grades in lots eliminates warehouse grading. The length-for-grade system emphasizes dividing grades into commercial length groups as practiced in chute grading before shearing. In 1955 approximately 573,000 head of sheep were classified under the New Mexico wool improvement system compared to 375,000 head in 1954. From the total number of sheep classified in 1955 there was a total of 1,101,100 pounds of wool length-for-grade labeled for market as compared to 500,000 pounds during the previous year. Returns to ranchers cooperating in the wool improvement program are estimated to have benefited the industry in excess of 1 million dollars.

In Montana the program is directed at creating a greater understanding and use of grades in marketing sheep and wool; providing information on the organization and efficient operation of lamb and wool pools; providing price and other market information that will result in the more orderly movement of lambs and wool through market channels; and establishing improved practices of preparing wool for market. As a result of this work an increasing proportion of lambs and wool are moving through market channels in a more orderly manner and on a quality basis and reflecting increased income to producers. In 1953 the growers in one area decided that they could profit from getting more lambs off as fats by timely and orderly marketings through a lamb pool organization. A pool was organized and over 50 percent of the lambs were sold as fats in 1955 as compared to only a small proportion in 1953. In 1955 the fat lambs brought as much as \$2 per hundred more than those sold as feeders. There has been no discount for shrinkage from local buyers if sold at shipping point. There is renewed interest in the production and marketing of farm flock sheep in the area. The need for educational work in marketing of both wool and lambs continues to increase because of this expansion. Although pool marketing of wool in Montana is almost complete on an organization basis, a considerable number of lamb pools are still needed.

In Utah emphasis has been directed at providing timely price, outlook and other market information pertaining to sheep and wool; bringing about a greater understanding and use of grades, improving practice of preparing wool for market and core testing. The orderly movement of sheep and wool through market channels, and improved marketing practices have also been stressed. As a result an increasing proportion of the wool is being graded. In 1955 it is estimated that

90 percent of the clip will be graded before final sale. The information obtained from grading will be used as a guide in developing future extension programs. Significant results also have been obtained from encouraging producers, particularly farm flock producers, to market lambs in June or early July when the price is at a seasonal peak. In one area 93 producers adjusted breeding and feeding programs to take advantage of the seasonal high market prices.

In Wisconsin emphasis is directed at providing outlook and market information on sheep and wool; bringing about a greater understanding and use of grades and encouraging the movement of lambs through market channels in a more orderly manner. Assistance is being provided on the organization and operation of lamb pools. Lamb pools were inaugurated in 1954. During that year, 2,200 lambs were marketed in this manner and in 1955, the number marketed through pools had more than doubled.

In addition to the work reported above, livestock marketing workers in other States have helped in assembling and disseminating outlook and market information pertaining to sheep and wool and with the educational phase of the Wool Act.

2. Marketing Information for Consumers

FES

It is recognized that in solving the problems of marketing farm products it is necessary to work directly with consumers as well as handlers and farmers. Forty States, Puerto Rico, and Hawaii are now conducting an educational program aimed at providing food marketing information to consumers, which includes information on lamb and mutton. The work is being conducted, primarily, in the major urban areas with programs in 71 cities. The potential audience to be reached in the areas comprises about one-half of the population of the United States. The workers on marketing information programs for consumers regularly collect, interpret, and disseminate current localized food marketing information. Radio, newspaper, and television are the major media used to get the information to consumers.

PROPOSALS FOR COMMITTEE CONSIDERATION

1. Increasing the Efficiency of Marketing Sheep

Expand the program directed at increasing the efficiency of marketing sheep. This will include bringing about the more orderly movement of sheep and lambs through market channels, assisting in the establishment and efficient operation of lamb pools, reducing losses from bruising and shrinkage that takes place in loading, in transit, in yards and in packing houses, and establishing more efficient market facilities and methods of operation.

2. Correlation of Live and Carcass Grades

Expand and intensify the educational program to bring about a greater understanding and correlation of live and carcass grades through demonstrations and other educational means that will show the correlation of these grades.

3. Improving the Preparation of Wool for Market

Expand the program to improve the preparation of wool for market with special emphasis on care in shearing, preparation of fleeces, and segregation on a quality basis.

4. Increasing the Efficiency of Assembling and Marketing of Wool

Expand and further develop educational work on grades and their application to improved marketing practices, and on the establishment and efficient operation of wool pools.

5. Disseminating and Interpreting Market and Outlook Information

Expand the program for disseminating market and outlook information and assisting in its interpretation as a guide to adjusting production and marketing of sheep and wool to anticipated demand. This will include information on the current and prospective demand and supply and other market information relating to the sheep and wool situation and educational work in connection with the Wool Act.

6. Marketing Information for Consumers

Expand the dissemination of marketing information to consumers on lamb and mutton. Such information would be directed toward assisting consumers in obtaining greater satisfaction from their lamb and mutton purchases by providing more information on availability, quality, selection for alternative uses and care.

